

**ORAL
COMMUNICATION
of
TECHNICAL INFORMATION**

CASEY



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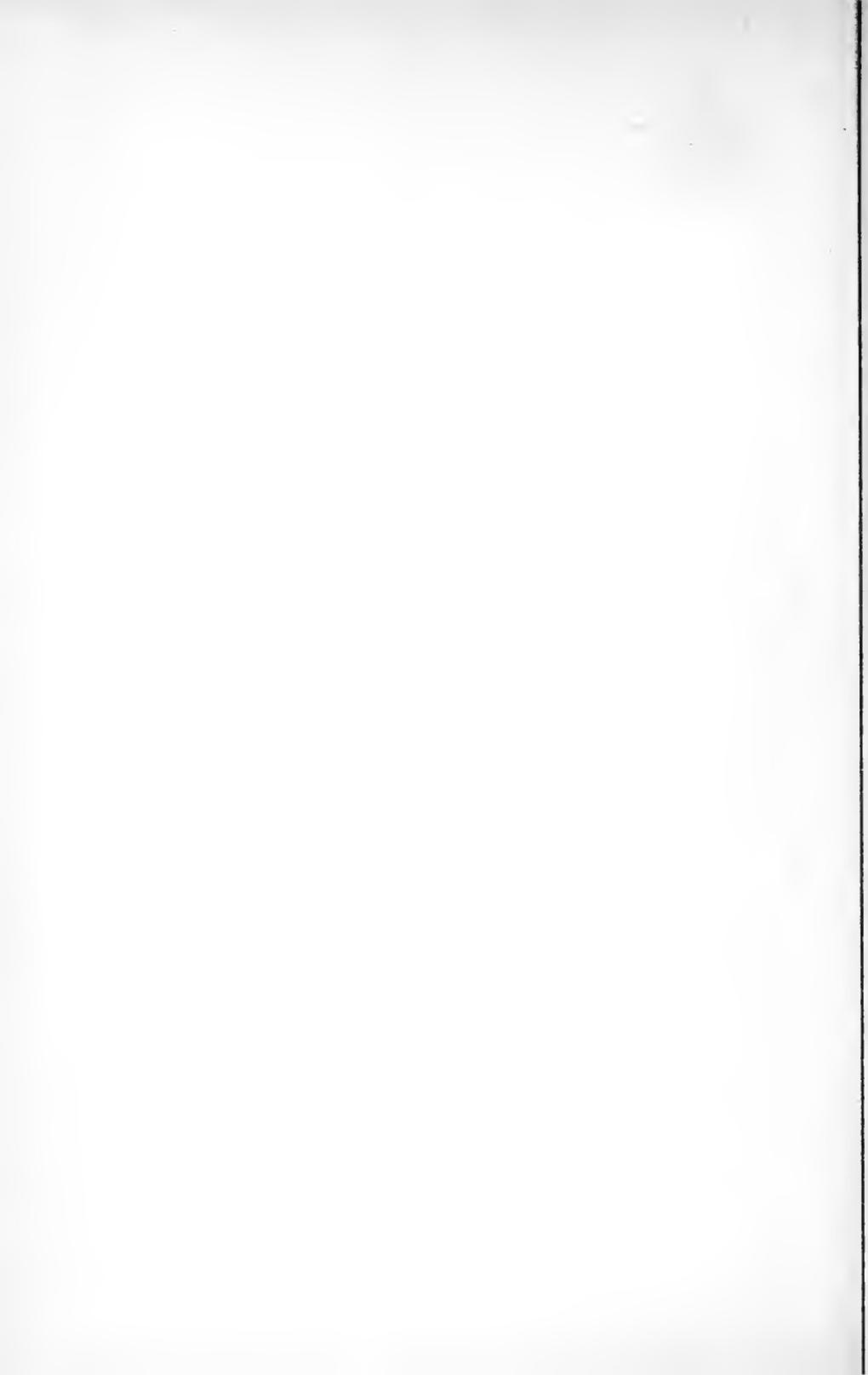


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ORAL COMMUNICATION

of

Technical Information

ROBERT S. CASEY

W. A. Sheaffer Pen Co.

Fort Madison, Iowa

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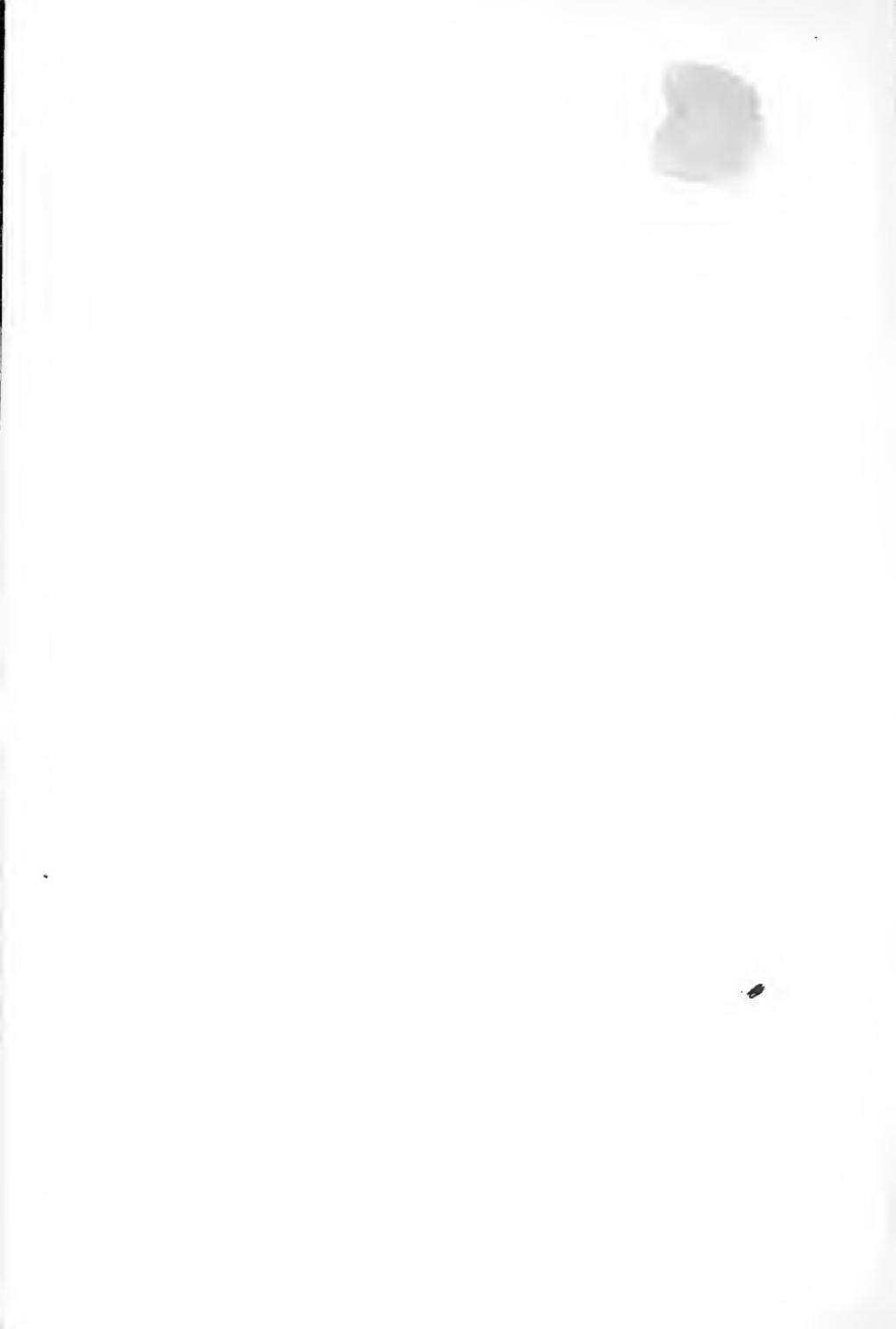
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Dedicated to
HELEN and SALLY,
the literary
members of the family.



PREFACE

The purpose in writing this book was to assemble, organize and make available the information that will help technical people tell things well and to emphasize the fact that most of us need such help. The central thought has been on "help," and "how to do it." Learning to speak more effectively is, of necessity, a do-it-yourself project.

The book should be useful to students, to young and old practicing scientists and engineers and to others in non-technical fields because, although the emphasis is on *technical* information, many of the techniques described in the book apply to *all* speaking situations. Hence, this book should be useful as a text and reference in courses of instruction in schools, universities and industry.

Much has been written on the need for improved oral communication, and many helpful suggestions have been offered but the articles are widely scattered, however, and most describe the presentation of papers at scientific meetings, how to make slides or business conference techniques. I do not know of any other book currently available that covers the full scope of oral communication as outlined in the Introduction, Table 1. In this book I collected and reviewed the information offered by the authors cited in the references and added some original suggestions and interpretations. The

bibliography is selective rather than exhaustive. Some references are marked "Recommended Reading." In those references, the reader will find additional information, a new viewpoint on entertainment in addition to enlightenment. That notation is not intended as an indication of relative merit because most of the essential information in the other references is fully reviewed in the book, or the title or annotation will tell the reader what he will find in the article.

I gratefully acknowledge the help of many friends, and hope that all friends, old and new, will tell me about mistakes and omissions which should be corrected in a later edition, if that happy estate should come to pass. My special thanks go to my employer, The W. A. Sheaffer Pen Company, for the use of company facilities in the preparation of parts of this book, to my secretary, Mrs. Dorothy Billman, for the typing and other help, to Mrs. John R. Weber, Gordon H. Armbruster, A. L. Terlouw and R. N. Johnson, Jr.

ROBERT S. CASEY

Fort Madison, Iowa
July 1957.

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I. INTRODUCTION

Importance and Scope of Oral Communication

Facts do *not* speak for themselves. You have to "get 'em across." Your facts can't speak at all until they are understood by your listeners.

Creating comprehension in the minds of other people is the only useful thing we do when we talk. Telling how to do that more effectively is the object of this book.

We are all called upon to do some or many of the things outlined in Table 1. We'll get along better if we do them well. Our economic well-being depends on our employer's awareness of the value of the work we're doing for him. Our professional standing depends on our colleagues' opinions of our work. The standing of our profession in the eyes of the public depends on what we tell and how well we tell it. A student's grades depend on how well he tells his instructors what he knows.

TABLE 1. ORAL REPORTS

Informal—impromptu

Everyday conversations

Student replying to instructor

Discussions with colleagues

Replies to immediate superior

Instructions to and discussion with subordinates

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Semi-formal

Answering requests for technical information from departments in own organization:

- Advertising
- Patent
- Public Relations
- Purchasing
- Safety
- Sales

- Field trips, trouble shooting in own or customers' plants
- Discussions with dealers and salesmen
- Descriptions and directions for use of company's product, process or equipment
- Technical testimony in court
- Conferences

Formally Prepared

- Student giving a report in class
- Reports to superiors
- Reports to colleagues and representatives from production, engineering, research and other technical departments
- Papers at meetings of scientific societies
- Talks to laymen: clubs, schools, civic groups, radio, TV

Most jobs depend, at least in part, on coordinating our own work with that of others, and giving instructions to those who work for us.

We all think we speak well. Because we know what we mean when we talk, we think that others will get the same meaning. However, that just isn't always so. We have all seen how gossip and rumors become

garbled when repeated from person to person. Try playing that old parlor game where one person whispers a statement into his neighbor's ear, the latter whispers the statement to the next person, and so on around the room. Then the last person repeats aloud the statement he heard, and it usually bears little resemblance to the original.

We do need to improve our ability to transmit thoughts, ideas and facts to other people. The ability to get along with others ranks high among the requirements for success in science and engineering and, of course, in most other fields as well. Effective communication is an important means to this end.

Most national scientific and engineering societies have instituted projects with instruction for speakers, to improve the presentation of papers at meetings.

Men in industry have been showing more and more concern with the need for improved communication.

"Here I am using the term (communications) in its broadest sense to include everything from presentation of papers at an American Chemical Society meeting to the internal communications one has with himself, such as hypothesizing and planning.... Industry must realize that inability to communicate is a more serious deficiency than just 'not being able to write a report.' Psychologists have found that man thinks only in an articulate fashion. Speaking, either vocal or silent, writing, and figuring are the tools of both thinking and communicating. Thus, the inability to communicate with others may also mean that the fellow will do a job of communicating with himself, i.e., imagining, hypothesizing, and generalizing below his real ability.

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Thus, training in this field will likely improve both his personality and importantly, his thinking qualities.”²

“Communications: Person to Person”¹ describes a chemical company’s plan to rely less on written reports and to allow the research men more opportunity to make their reports orally.

Preparation of Oral Reports

The steps in preparation of oral reports are:

- (1) Collection of the information
- (2) Organization
- (3) Composition
- (4) Delivery

The information may be from such sources as original laboratory work, production figures or new process results or other observations from field and plant trips, cost and other financial statistics, or literature review.

Your facts, figures and conclusions are of no use until they have been delivered to your audience. And that doesn’t mean just dumping the packing cases off the truck onto his front porch. You must help him unpack and show him how to use the contents. Your information must be well organized and composed and told to your listener in a way that he understands.

The method of organizing the information for oral reports is similar to that for written reports. However, it is even more important in oral reports that the facts and conclusions be arranged, not only in logical order, but in the most easily understandable manner. It is necessary to orient and guide the listener through the

talk. If the listener misses a point or misunderstands a transition, he can't stop and turn back to check up, as a reader can.

The composition of an oral report is similar to that of a written report but the style is more informal. The talk should be delivered in *spoken* English. When speaking, we use more colloquialisms, contractions and personal pronouns. The style for an oral report should be conversational.

The delivery of your oral report is more than just telling it. Don't look now, but your personality is showing. You need more than a thorough understanding of your subject. With a good delivery, your conviction, sincerity and enthusiasm will keep your listeners alert and interested. If you "know it but can't tell it," your listeners will conclude, correctly, that you don't know it well enough.

The four steps—collection, organization, composition and delivery—should be considered as belonging together. Although they are listed in the order in which the work is done, each step must be considered in its relation to the others. The facts and figures collected must be suitable to the occasion and the audience. The organization of the ideas is for the purpose of aiding the composition, and during every step you must be thinking of the listeners. All the steps must be used effectively if you are to "get it across."

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2. BARRIERS AND BRIDGES

The person you are speaking to isn't an ambulatory tape recorder who receives your words just as you say and mean them. His background, interests, status, state of digestion and feelings at that particular moment influence his comprehension and *interpretation* of what you're saying.

When a man says to his wife, "How soon will supper be ready?" he may mean, "Will I have time to change my shirt?" When she answers, "Can't you see I'm getting it ready just as fast as I can?" she understood his question to mean "Will you quit fooling around and hurry up and get my supper?"

Later chapters will tell something about how to put your thoughts into words and how to say the words. This chapter will review some of the things psychologists and other experts have written about semantics and the psychology of comprehension—things you need to think about *before* and *while* you write and speak. Successful talking isn't merely emitting well chosen words. The object is to create understanding in the mind of your listener, and there you are dealing with the most complex thing in the world. No two minds are alike. No one mind reacts the same from day to day or even from hour to hour.

Also, there are potent means of communication other than words. Your attitude, inattention or silence, past

and present actions all speak louder than words, and strongly influence the effectiveness of your attempts to communicate. You must also take into consideration how *your* mind and emotions are working when you are listening and when you have something to say.

Some of the things men in industry need to communicate to one another, some of the difficulties, and some of the ways to improvement are discussed in references 1, 3, and 5. Although the articles refer to communications in industry, the principles apply equally well to communication in general.

What men need to communicate to each other may be categorized as facts, purposes, feelings, and recognition. The communication of facts presents few psychological difficulties if all other factors are in good order. Purposes are as important as facts. When we receive an order from our boss, or see a notice on the company bulletin board, we want to know "Why are they doing that?" and "What do they mean by that?" Communication of feelings is equally important. Often people can't communicate adequately unless each knows how the other feels. A person can communicate best if he has the attention and sympathetic understanding of the other fellow.

Facts, purposes and feelings contribute to making up the psychological context between speaker and listener and all are fundamental elements of *meaning*. And what we are trying to convey to a listener is meaning. For effective communication, that is, thorough understanding, the words we speak must have the same meaning for the listeners as for the speaker.

Finally, we need to communicate the fact that we recognize another person as an individual. People need to know that the job they are doing is important. People need to feel the esteem of their fellow men. It may be no more than the usual small talk, "Hi, Joe, nice day, isn't it?" "How does your boy like it at the University?" Much of the small talk and even inanity that we hear means that some person wants to be friendly and wants to hear us respond, wants the recognition and human warmth that we all need. Unless this kind of human contact is maintained, communication of facts and purposes is likely to fail.

Words can carry reports or inferences or judgments. The three are quite different, but it is not always easy to distinguish between them. If we say, "Brown has been in the boss's office since one-thirty," that is a factual report. If we say instead, "Brown must be getting an awful bawling out," that is inference based on the fact that Brown has been in the boss's office since one-thirty, and based also on previous observations and inferences. If we say, "It will be a lot better around here now that the boss has caught on to Brown," we are making a judgment based on the inference. A judgment based only on the fact might be, "Someone else will have to help with those tests Brown was going to run this afternoon."

In our listening and in our own thinking before we speak, we must distinguish the difference between the objective statement of fact, the inference based on the fact, and the judgment based on the fact or on the inference or on both. In our listening we must recognize, and in our speaking avoid, inferences which are based on judgments which are based on inferences.

Psychological Filtering

Our experience, hopes, fears and doubts have built up circuits in our minds that receive certain ideas readily, that reject others, that attribute one meaning to a word or phrase when perhaps another meaning was intended.

Just as a laboratory filter holds back particles above a certain size, and a color filter absorbs energy of certain wavelengths, so our minds color or preferentially absorb certain parts of what we hear and read. In our minds, as in most electronic systems, there is a non-linear relationship between input and output.

Brighouse¹ reports a story to illustrate this filtering property. During the depression a large flop house required that each applicant be interviewed to find out why he needed help. The interviewers were carefully selected and were thought to be well trained. One was an ardent prohibitionist, another an ardent socialist. The prohibitionist found that 75 per cent of the men were down and out because of the evils of alcohol; the socialist found that fewer than 10 per cent were there because of alcohol. The prohibitionist found that 8 per cent were there because of economic difficulties; the socialist found that 80 per cent were there because of the economic system. These interviewers were not lying; they heard different things because of their own strongly developed filtering systems. That, of course, is an extreme case, but each of us does have a unique mental filter.

Actually this is more than filtering—rather our feel-

ings and emotions structure what we hear or what is said so that the meaning of a word, a sentence, or an utterance can be described only in terms of the listener's interpretation or reaction, which in turn may be similar or dissimilar, as the case may be, from that of the speaker.

Psychological Context

When peoples' mental filters become clogged with subjective feelings or strong emotions, mutual trust and congeniality between speaker and listener disappear, and a powerful deterrent to communication is established. In that unfortunate state *what* is being said is the last thing the listener considers. He considers *who* is saying it, and *why* he is saying it. The context, the whole of the relationship that exists between listener and speaker, is like a lens that must be in focus if it is to transmit rather than distort the message.

As the distrust probably came first, it was the reason why the filters became clogged. The distrust was caused by poor communication—words, actions, or inconsistency between words and actions; or some communication preceding the distrust may have been unconsciously or deliberately colored and slanted to excite emotion. That kind of communication—the most deplorable type of all—is usually addressed to a certain group or segment of the population against another group. It is usually concerned with such abstract and potentially emotional topics as political and economic principles and relations, and racial and religious differences.

*Fortune*⁵ describes an experiment that illustrates the effect of context. It was a type of experiment that anyone can try on his associates. A cartoon chart, "The Four Goals of Labor," was clipped from a C.I.O. newspaper. It was reproduced with a new legend at the bottom stating that it was reprinted from the National Association of Manufacturers' Newsletter. The ad was then shown to twenty C.I.O. members who were asked if they thought it was a fair presentation of labor's goals. Four grudgingly admitted it was and two couldn't make up their minds. The other fourteen called it "patronizing," "loaded," "paternalistic," "makes me want to spit." This also seems like an extreme example, but you could get similar results from Management, Republicans, Democrats or other groups.

Each person has his own context for each situation. This is true even in a group of people whose experiences have ostensibly been similar and who are working at similar jobs but whose individual backgrounds may be different.

Feedback

Misunderstandings due to psychological filtering and to other causes are greatly lessened by "feedback"—the listener asks questions, two or more people talk back and forth freely. "Feedback" is a term borrowed from electrical engineers, who use it to mean that a part of the output of an electrical device is led back to the input to improve the accuracy of control.

Brighouse¹ describes an experiment in oral communication illustrating the value of feedback. Some

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experienced "senders"—college professors in various fields—were asked to communicate a particular kind of material to groups of "receivers." The sender had in his hand a card bearing a geometrical diagram, which he was to describe orally. The receivers were to visualize and draw the diagram.

Under conditions of free feedback where the sender and receivers could see each other and the latter could ask questions, as would be expected, the accuracy was better than under zero feedback where the sender was behind a screen and the receivers could not ask questions. When conditions were changed from zero to free feedback, both sender and receivers felt greater confidence. Both sender and receivers improved with practice under both conditions, but to a much greater extent with free feedback.

Finally, and most important of all for human relations, under zero feedback resentments built up in the receivers. They found it frustrating to get messages and not be able to question and verify what they received. When conditions were changed to free feedback, even with a different sender, the initial effect was that hostility was directed back to the sender. However, under the conditions of free feedback, when the receivers could speak, the hostility was quickly dissipated.

This has an important lesson for industry. In a department where upward communication has been stifled, resentments build up. Then the boss reads somewhere that he should adopt an open door policy and all will be sweetness and light. So he opens the door and he gets only negative material—his people tell him

only the things they don't like. The boss is dismayed at this and decides that psychology is the bunk. He closes the door again and goes back to the policy of "Tell 'em and make 'em like it."

Listen

If the boss had listened to the complaints, no matter how trivial or irrelevant they seemed to him, the hostility soon would have decreased. If a person can merely tell someone what troubles him, the trouble suddenly becomes less important.

Listening is the great communication catalyst. Listening while someone talks induces a catharsis that influences the talker's mind more profoundly and is more persuasive than anything *we* could say. And it is possible, believe it or not, that we might learn something we didn't know before. But, from the human relations standpoint, just as important as listening for facts, is listening sympathetically to let the other person "get things off his chest," "blow off steam." The wise boss lets the employee tell his whole story. Maybe after the first sentence the boss could have answered the complaint, told the reason or said, "We'll correct that right away," but lets him finish. The original complaint may have been trivial and perhaps after sympathetic questioning the *real* trouble will come out.

Of course, the boss must do more than listen. He must take appropriate action about the things he has heard. He must fulfill the promises he has made.

Listening unclogs communication channels. If we listen first, there is a better chance that what *we* say

will "get across." We have all noticed in everyday social conversations and discussions that while we are expounding our theories and arguments the "listener" isn't listening. He's just waiting until the balloon juice blows past so he can tell *us* something. We might just as well stop and let him speak because he's not going to hear, let alone understand and take to heart, a single word we say until he has had *his* say.

Semantic Obstacles^{7, 8}

The connection between a word and the thing or idea it represents is through a multi-step process. The sound or sight of a word sends a message to the brain, the

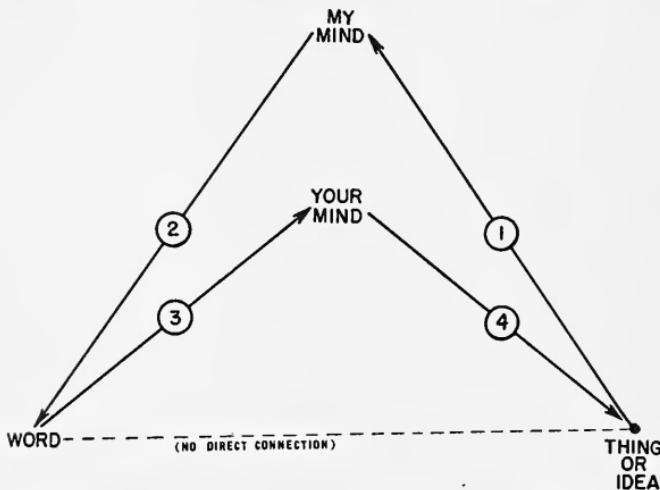


Figure 1. The Relationship Between Word, Thought and a Physical Object. (Adapted from Ogden and Richards.⁹)

sight or thought of a thing or idea sends a message to the brain, and the brain then makes the connection between the word and the idea. There is no *direct*

connection between word and idea except in the few cases where the sound of the word represents the idea, "hiss," "murmur," "gurgle." The four steps in Figure 1 illustrate the process of communication for words that represent simple material things, like "knife" or "chair."

However, many words have more than one specific meaning. For example, "slip" can mean,

—in common parlance:

- fall on the ice
- a verbal indiscretion
- a woman's garment
- surreptitious exchange of currency
- a small piece of paper
- space for a ship
- fabric cover for a pillow or furniture

—to a ceramic engineer:

- an aqueous suspension of potter's clay

—to a metallurgist:

- deformation of metal crystals along certain planes

—to an electrical engineer:

- the difference between the speed of the rotor in
an induction motor and the synchronous speed

Other examples:

basic:

- fundamental
- alkaline

fine:

- small in diameter or particle size
- high quality

long:

- in time
- in space

Figure 2 illustrates the process that may take place when the verbal context does not make clear which specific meaning is intended. The speaker and the listener each picks a different small segment of meaning out of the total area of meaning encompassed by the word. The circle encloses the broad general idea represented by the word. For example, the word "slip" represents the broad concept of friction-free motion

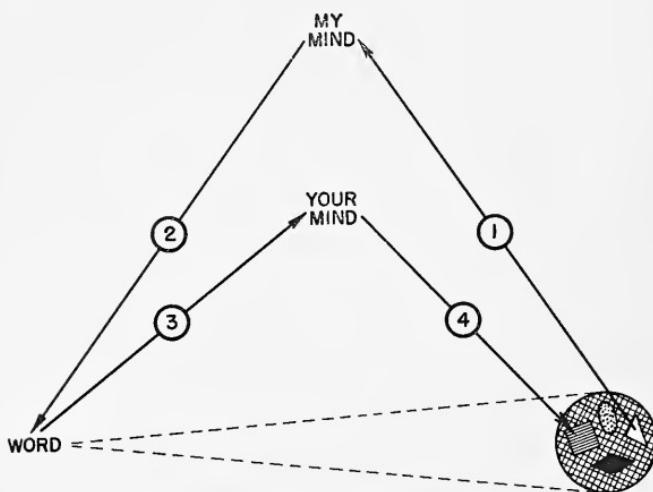


Figure 2. The Reaction That May Take Place When a Word with Multiple Meanings is Used.
(Adapted from Ogden and Richards.⁹)

between two or more objects. The geometric figures inside the circle represent specific meanings derived from the general concept. From "slip" come such derived meanings as a garment or cover that "slips" on and off easily; we let the wrong word "slip" out. The various meanings of some words, like "slip," are specific

and well defined, and the verbal context usually makes clear which meaning is intended.

The trouble starts when we use abstractions—words having many connotations whose meanings are ill defined and overlapping, for example, “security,” “democratic,” “initiative.” Some abstract words are merely vague and indefinite; others are highly charged with emotional implications.

Abstractions mean different things to different people. For example, *Fortune*⁵ points out that business men consider themselves united on the principles of “free enterprise,” yet a prominent merchandiser announces that too much saving will wreck the system, and insurance companies take full-page ads to say that the system is founded on thrift. Also, there are fair traders and anti-fair traders, free traders and protectionists each thinking the other’s philosophy is imimical to the American Way of Life.

The psychological context we have previously established with our listeners determines the meaning that is conveyed. Unfortunately, we can’t always create the kind of psychological context we would like to have. Social, educational and economic status differences are always with us: it’s still the boss who is speaking or listening whether behind his desk or out in the plant, although in the latter place the tension may be less. Emotional ups and downs will always exist: your listener may have just received his income tax notice, or stayed up all night with his sick child. At best we must try to recognize the psychological context and make the words fit the situation.

Sex

Similarly, communication between the sexes is beset with barriers, not only language, the choice of words, but more particularly subjective aspects. We may fail to consider how different from our own are the feelings, experience and interests of the other person. Men are likely to consider a communication adequate if it gives "facts," "reason," and "logic." Women are more likely to be interested in people and feelings. Misunderstandings should be avoided if possible even though the verbal difficulties are often amusing rather than troublesome.

Women seem to comprehend motives, feelings and intent on some unknown wavelength without the need for oral communication. They are born with a built-in non-electronic lie detector. Furthermore, when discussion of mechanical or functional aspects of material things cannot be avoided, the mention is compressed to a terrifying and strangely illuminating simplicity.

When we were remodeling our first house I yearned to have a shower in the bathroom, although we couldn't afford the built-in type. So my wife said, "You can fix a strainer and a rope."

We of the male persuasion can usually understand Femalia, the native tongue of my favorite sex, except when the ladies are talking to one another. We probably will never learn to speak it fluently, but we can and certainly should try to make our own jargon more intelligible.

Reported below are two communication failures in this field.

I went over to my neighbor's house to borrow a garden implement. The lady of the house was at the back door and I asked if I could borrow their grass-trimming device. She said she didn't think they had such a thing. I then delivered a well organized description of the clipper (I had used it many times). My description could have been used in a sales brochure. It covered the appearance, mechanical features and functioning, all in meticulous detail. Finally, after I had made more sounds and motions, she pointed to the garage wall and said, "Oh you mean the thing that hangs." And sure enough, there was the-thing-that-hangs *hanging*. The other garden implements were *leaning*.

Another time I was having a philosophical discussion with a young lady on life in general and the thinking of men and women in particular. I suggested that, generally, men take an objective viewpoint, and women are likely to have a subjective or personal reaction. The lady bristled with indignation and said "I do not!"

Empathy

In the same way that organization, composition and delivery are interrelated, so must considerations of human relations pervade every step of the communication process. They must be in your mind while you're choosing and arranging the facts or arguments, while you're selecting and saying the words, and while you're planning and presenting the tables, charts or demonstration.

Most people know that for the proper functioning of

a complicated machine they must consider its structure, age, purpose and inherent limitations and above all must keep it well oiled. The most complex mechanism of all, a human being, also functions best with plenty of the good old oil. A learned name for this oil is *empathy*, which may be freely translated as human understanding.

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3. WORK HABITS AND METHODS: HOW TO DO IT

Most experts recommend that you actually write your oral report, especially a formal report. Writing is work. For even the most informal oral report you must plan, make an outline, organize. That is work. So, form efficient work habits. Forming good habits while planning and writing will help your thinking when you speak extemporaneously.

Place

Pick a special work place. If you are working at home after hours and on weekends, don't try to work in your usual comfortable place where you read the paper and relax. Sit at a desk or table in a comfortable but upright chair in a place free from distractions. You will get the habit of doing nothing but work while you are in those surroundings. Early in the morning is a wonderful time to do creative work.

Plan

The start is not with pencil and paper, nor in the laboratory or library, but inside your own hard head. As the wall placards say, "THINK."

Who are you going to talk to?

Why are you going to talk?

What do your listeners want to know or need to know?

Why do they need to know it?

If your listeners need to know something but don't know that they need to know it, how are you going to make them *want* to know it?

How much do your listeners already know about the subject?

How much background and explanation will be necessary so they can understand the subject?

Where will you find the information you're going to tell?

Only after you've answered those questions should you go to the laboratory or library or wherever your information is. Start planning the report when you are planning the work that is to be reported.

Learn how to use a library. It will pay you to spend a little time studying some of the books on Library techniques and literature searching^{3, 5, 6, 9, 11}. What abstracting and indexing services cover the field you're studying? What books and reviews have been written on the subject? Learn to find the information you need.

When you start to study a complicated subject which is new to you, the first book or article you read probably will be difficult to understand thoroughly. If so, don't spend too much time going over and over this first one. Read other articles by different authors. Each author will have a different viewpoint and method of expression. Then go back and read the first article again and you will get more out of it than you did before.

Be Prepared

Think of the report while you are planning and doing the laboratory work or the field investigation or whatever may need to be reported. Plan and execute the work so that all necessary information will be on hand when a report is called for.

Think of what questions may be asked. Prepare more information than you will use in the talk, so you can answer peripheral questions.

Systematize

Have an orderly plan for collecting the information. The plan must include provision for storage and easy retrieval of the information. Start with a pocket notebook. Write down observations and ideas promptly. Write complete sentences. Jottings in telegraphic style are hard to decipher. Scribblings on backs of envelopes are likely to get lost.

Part of the note taking might well be audible "notes." Tape recorders and dictating machines have been recommended for recording notes in the laboratory such as instrument readings and observations of a rapidly changing phenomenon. A portable over-the-shoulder tape recorder can be taken on plant and field trips to record observations and interviews.

Don't overlook the occasional need for pictorial "notes," photographs taken to show results of progressive weathering or other tests, "Before and After" effects, construction progress, to record wiring, piping or other details which later will be obscured or buried.⁷

Also, a camera, especially the Polaroid Land, and other facsimile reproduction techniques, can sometimes be used for economical copying of pictures and text in the library.

File cards or slips of paper of uniform size are convenient for handling some kinds of information, especially literature references if you have more than about a dozen. Put each reference on a separate card, list author, title, journal or publisher, volume, pages and year of publication. Write an abstract of the article on the card, or note the pages that give the information you want to use.

If you have a number of individual topics, such as chemical compounds or pieces of machinery or equipment, each card or sheet of paper can be devoted to a single topic.

If you have a large amount of technical information of permanent value, it may be desirable to use punched cards which can be sorted and arranged mechanically¹. A full treatment of information handling is beyond the scope of this chapter. The reference just given contains several chapters on this subject and many references.

Be systematic but don't make your system more elaborate than is needed to do the job. The object of a system is to simplify whatever work you need to do.

Wherever and however you get your information, and whatever your system, work in an orderly way. Sloppy work habits reflect sloppy thinking, and will result in a sloppy report.

Do It Now

Don't put off starting work on your report. Don't think you can dash it off in a few minutes some rainy afternoon. It will take longer than you think. Start right now.

Put Your Subconscious Mind to Work

When you have a problem you review all the pertinent facts and information, and sometimes the solution doesn't come to you right away. You think you haven't made any headway at all, but thinking about it and arranging the known facts poses the problem for your subconscious mind. You forget about it, go fishing or take a walk, or go to bed and get a good night's sleep. Your subconscious mind was working on the problem during that time, and you will think of more and better ideas the next time you work on the problem than you did the time before. Sometimes the solution will come to you unexpectedly.

Your subconscious mind will work for you best if your conscious mind marshals the facts and conditions of the problem. Live, eat and sleep with your report; then when you start writing or speaking you are more likely to be prepared.

Getting Started

After you've organized your material, and have an outline and notes, you may find that it's hard to get the actual writing started. Kent⁸ suggests overcoming this

"initial block" by writing a personal letter. He says start a letter to a friend who is somewhat familiar with what you're doing. Begin with the usual preliminaries, "Dear Fred," a few sentences about your family, and mutual friends. Then tell him about your project. Begin at the beginning. Use your original format and plan, and keep on writing until you finish the chapter or section you were working on.

Once you get started writing, keep putting your thoughts down on paper as they flow. Don't think of rules of grammar, don't stop to correct and polish what you've written. Do that later. Concentrate on the subject. Your composition will have better unity and coherence if you write down your thoughts as they come to you.

Sometimes you will feel that you have a certain section of your report well prepared in your mind. Then go ahead and write it even though it may be in the middle of the report. Do the same with other sections even though you may not have the outline completely organized. That method of getting started is especially useful when the subject is complicated and difficult to organize. Arranging the sections after they're written will help with the organization.

Write or Dictate?

So far it has been assumed that you are writing with pencil and paper. Some writers recommend dictating the first draft to a stenographer or dictating machine, and editing the typed transcript. There are advantages and disadvantages to each method. When writing with

a pencil you can see what you have just written, and so avoid repetition of words and phrases. Also, your first draft is likely to be simpler and more coherent than when dictating, and so will need less revision. However, sometimes you can't write fast enough to keep up with your thoughts, and this hinders consecutive thinking.

Another advantage of dictating is that you are more likely to dictate as you naturally speak—to use your *own* words rather than "composition" words or "speech" words. A possible disadvantage of dictating is that your sentences may be too long and complicated, and the whole construction awkward. The typed draft then requires excessive editing and rewriting. The choice depends on whichever method works best for you. In either case, double space the lines and leave wide margins for corrections.

Correct and Rewrite

After you have finished the first draft of your report, don't try to polish and correct it right away. If you read a manuscript soon after you have written it, you will remember what you were thinking about while you were writing, instead of reading what the words actually say. Forget about it for at least several days. Then pretend someone else wrote it and read it critically and see if you can understand what that other fellow meant. You will probably find passages that are obscure, or at least that can be improved.

Also, reconsider the organization. Your original outline was merely a guide—it was the best you could do before you started writing. Don't force the report to fit

the outline. Study the report again for the treatment and development of main topics. Do they follow one after another smoothly, and lead to the conclusion?

It's a temptation to relax and admire what you've worked so hard to prepare. But it's better to be worried about it. Try to think what you could have overlooked. What can go wrong that will spoil your presentation?

Edit your manuscript ruthlessly: eliminate, consolidate, rearrange where necessary. Have the manuscript retyped and put it away again. Repeat as often as necessary. When your manuscript is approaching the final draft, have it read and criticized by some of your friends. If possible, include at least one whose background and interests make him representative of your intended audience. You should welcome criticism and editorial assistance. You probably will be surprised at the amount of improvement you can make in your manuscript by hearing the comments of people who read it with a fresh and detached viewpoint. If their suggested changes are more than just a word or two, have the revision typed. Then read the revised version before you check to see what was changed.

Incidentally, do the same with galley proof of your articles which journal editors return to you. When you read the galley proof you will usually think that it sounds mighty nice, that you are a pretty sharp writer. It has a very healthful effect on the ego then to check with your original manuscript and see how much was changed or eliminated.

If your report is informal and you can deliver it from notes without writing it out in full, practice giving it orally to friends in private. Ask for their criticisms and

comments. This practice is very helpful. Their questions about the subject matter will show where you need to eliminate ambiguities. If possible, record your talk on wire or tape and listen to it.

Even if you are going to deliver your talk from notes, it will help you if you first actually write it. It has been said semi-facetiously, "If you want to learn about something, write a book about it," but nothing could be closer to the truth. In the same way, a student in school will learn more and get better grades if he will write what the lesson was about after he has read the assignment in the book or studied his lecture notes. He will find that there are some things he didn't remember or couldn't reconstruct and he has to go back and study them again. Nothing can clarify your understanding of a subject like writing about it.

Composition and Words

Try to get the *feel* of good composition. You can't get it entirely from studying instructions about what *not* to do. Read. That is the only way you can get a feeling for words and sentence structure and an appreciation for effective style. You can look up words in a dictionary and in a manual of usage, and you should when necessary; but the most effective way to learn words is to read. Read almost anything that interests you provided that it is well written by a competent author.

You need to know words, not only to express your thoughts, but to search an index. You need to know what words might be used to represent the different aspects of the subject you are looking for.

Surveys of chemical engineers and other groups have shown that the responsibility of the position held and the individual's earnings correlated directly with the extent of his vocabulary. Of course, words alone can't do all that. Perhaps it was the inquisitive mind that was responsible for success, the mind which soaked up a lot of other useful facts as well as meanings of words. Perhaps his increasing vocabulary helped him think in a more articulate fashion. And perhaps, even more important, it may have enabled him to influence the thoughts and actions of other people.

Sharp¹⁰ quotes Philip W. Swain as saying, "Other things being equal, skill with words will add between \$20,000 and \$100,000 to an engineer's lifetime earnings." Note that he says "*skill with words.*"

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4. ORGANIZATION

All authorities on report preparation emphasize first of all, the necessity for having a definite plan for presenting the information to be covered in the report. All the facts or arguments must be arranged in such a way that they can be most easily understood by the listeners.

Adequate organization of the information goes far beyond a preliminary outline of main subject headings, or a tabulation of "Introduction—Experimental Procedures—Conclusions," although such a broad outline or tabulation should be made as a start. Each sentence in each paragraph and each paragraph in each section must be similarly planned. A good presentation is impossible without good organization and careful preliminary planning.

Various authorities liken the preliminary organization to the framework of a house, and to developing a flight plan before taking off.

The mental exercise of working up a good outline is an essential pre-requisite to delivering a good report. You can't tell anything adequately until you have studied, analyzed and organized the facts and ideas you want to present.

Kapp⁴ says that the three aspects of exposition are linguistics, logic and psychology, but that mastery of English is less important than either logic or awareness of the person addressed. One may write "grammatical

and elegant sentences" and yet not convey the intended meaning to the listener. However, logic is essential. And logic involves consideration of the listener and his needs. Facts and arguments should be presented in the order in which they can be most easily received and that is the most logical order. The person addressed should be spared having what is irrelevant inflicted on him; he should be spared having more than one theme at a time inflicted on him. To express oneself with precision, one must think clearly, not only about the information being presented, but also about the person to whom it is presented.

However, don't smother your listeners with "logic." Note again Kapps' definition of logic—"Facts and arguments . . . presented in the order in which they can be most easily *received*."

In organizing the material for your talk, your "logic" might be impeccable, and still you could lose your listener's interest, and consequently his attention, before you get to your conclusion. So forget about *abstract* ideas of "logical" order. Think of logic as meaning that you divide your subject matter into bits and arrange the bits so that your listeners can most easily understand them and their relation to one another. Be logical, but don't let your listeners know it.

Outline

Whatever kind of report you're preparing and whatever the subject, make an outline. The outline may be in topic or sentence form. A topic outline uses nouns or

noun equivalents for the headings. This form is adaptable to generalized statements. The sentence outline consists of complete, concise sentences for each main and subordinate heading. The sentence form requires specific and accurate statements.

Your first draft of the outline will probably be in generalized, topic form, with a single word or phrase for each heading. As this is expanded and filled in, write specific sentences for the headings. This brings your ideas of the subject matter into more definite focus. Also, these sentences provide the openings for the various sections of the report. Kerekes and Winfrey⁵ give a good discussion of outlines with examples.

After you have a broad outline of the main subject divisions, treat each division as a separate unit. Space these subject units on a page so that notes may be added under each, or put each subject unit on a separate page so there will be more room for notes under each one. These notes are the facts and details you want to tell your listeners. During your study, reading and planning for the talk you will think of many facts, ideas and bits of information you will want to use. Write each one down under the appropriate unit in your outline.

It may be that you won't have a clear idea of what the subject headings should be when you start. In that case, collect your facts, ideas and notes first. Collecting and studying them may give you ideas of how they should be grouped. When the subject is complicated and the making of an outline is difficult, Prince, quoted in reference³, suggests writing first and making the outline afterward. He says:

- “1. Start writing anywhere but start a new page whenever the subject is changed.
2. Go over the notes and write an appropriate headline for each subject wherever you started a new page.
3. Copy these headlines, each on a separate card or slip of paper and arrange them in logical sequence.
4. Differentiate headlines into main heads, subheads, and so on, by marking them I, A, 1, a, (1), (a) in that order. This divides copy into chapters, sections and paragraphs.
5. Check copy for completeness and conciseness. The sequence of headlines will show where something is missing or redundant.”

After you have some sort of outline, your notes and sentences under each main subject unit should be arranged and organized as if that unit were a separate report.

This brings us to consideration of the techniques for extending the organization into the smaller units of the report—the sections and paragraphs. Most of the discussion so far has concerned the *over-all* organization, the arrangement of the information into a relatively few broad categories, the main subject units we've been talking about.

Special Techniques^{2, 6, 8}

Additional organizing techniques are described below, and are used in various ways and combinations according to the nature of the report. Some may be adaptable to the development of certain sections. Some

may be used throughout the report. Usually several of the techniques will be used in most reports.

A *generalization followed by detailed explanation* is a device frequently used throughout most reports. First, the report itself is the support and explanation of the generalization expressed in the title. Also, the statement of purpose and scope is another generalization which is developed in the report. The first paragraph of each section may be a general statement of what is to be developed in that section, and similarly each paragraph usually starts with a topic sentence.

Sequence is one of the most useful considerations in planning the organization. It is indispensable in sections involving description or procedure. You will usually present the data of your theory or method consecutively from first to last, or sometimes in the reverse order, although a very large mass of data or unusual complications may dictate exceptions.

A time sequence is usually most suitable for describing a laboratory procedure. Each step is described in the order in which it is to be performed.

Spatial or geographical sequence is used in describing a physical entity such as a piece of apparatus, or arrangement of equipment in a factory, or buildings on a plot of ground. First give a generalized over-all view, then pick a suitable starting point and describe each part, in order, from one end to the other. The relation between each part and the others must be kept clear, and the relation of the parts to the whole should be emphasized by occasionally referring to your preliminary generalized view.

Time and space sequences can often be employed

concurrently to increase clarity, as when you tell how to build something by giving the steps in chronological order, and at the same time call attention to the parts and their relation to each other.

Other sequences may be used; for example, data may be arranged in ascending or descending order of importance. If you are describing hazards, you will probably start with the most important, or the most prevalent, and proceed in order to the least important. When you're giving arguments for or against a proposal you will probably use the ascending order, leading up to the most important as a climax.

Proximity is the principle of placing sets of facts or statements in juxtaposition, or some other form of parallel arrangement. This is effective for emphasizing contrast, cause-and-effect or problem-and-solution relationships, or other comparisons.

A statement of production output when a previous process was used, followed immediately by a statement of present output, is more effective than separating the statements by a long build-up. It is an effective attention getter in the introduction. The build-up or explanation can come later. Similarly, judicious use of such pairs of statements can bolster your arguments, and make your theme more vivid.

Classification or logical division is the grouping of things or facts according to similarities and differences. This principle is useful in organization when you can arrange substances, facts or ideas into groups so that by a single statement you can apply some common explanation or description. This reduces the wordage and, more

important, fixes these similarities more clearly in the minds of your listeners.

First pick the *basis* on which the things or ideas are to be classified, the point of view to be brought out. For example, the substances studied in your project could be listed in groups according to their *form*—such as gases, liquids, crystalline solids, amorphous solids—or according to *color* or *boiling point*. In general, material things may be classified according to physical, chemical or biological characteristics, origin, composition, form, function, attributes, properties, behavior or other bases. Be sure to make clear to the listeners exactly what the basis is.

The classification must be consistent. Group the items according to only one basis at a time. The following list is not a proper classification:

- acids
- bases
- salts
- organic liquids
- lubricants
- solvents
- oxidizing agents

The first three items represent *composition*, the last three *function*. The item, “organic liquids,” represents *composition* and *form*. The terms are not mutually exclusive. Making a classification on a consistent basis automatically indicates general similarity in the items in each group, and the differences between the groups. You may then wish to characterize further a group of items which are similar according to the first basis of

classification, say "liquids." Now you will tell how each or any of the liquids *differs* from the others. The basis of the first classification was "form" or "state of aggregation." A sub-classification of the group, "liquids," might be on the basis of function or composition or something else. Perhaps some are lubricants for aluminum bearings; some are solvents for waxes; some are both; some are neither. A further classification on the basis of composition or boiling point may show that aromatic hydrocarbons having a boiling point less than 150°C are solvents, aromatic hydrocarbons having a molecular weight above 250 and boiling above 120°C are lubricants, aliphatic hydrocarbons are neither. Such a grouping would bring out the facts much more clearly and simply than by describing the substances one after another.

Partition or analysis is the process of dividing up a unit into its component parts, telling a little at a time for a better understanding of the whole. The parts may have nothing in common other than the fact that they belong to the same unit. The parts may be discussed from different viewpoints, and the same consistency in viewpoint must be observed as was described under Classification.

We could partition a drying oven by describing the *function* of the various parts; the air intake and blower—how many cubic feet of air per minute, the heating element and thermostatic control, temperature maintained; the air ducts and vents—how they regulate circulation through the drying chamber. Or we could describe the *construction* and physical characteristics of the various parts: the blower, fan or centrifugal; power

and electrical characteristics of the motor; power and construction of the heating element; operation of the thermostatic control, bimetallic element or liquid expansion; dimensions and materials used in construction of ducts and chamber.

Either viewpoint may be used, or both, one after the other, depending on the audience and the purpose of the report. But it is usually best not to mix the two viewpoints in the same description.

Technical Reports

Campbell¹ says that a technical report should supply the following information:

- (a) What question does the report attempt to answer?
- (b) Why does this question need an answer?
- (c) What answer was found?
- (d) How was the work done?
- (e) By what reasoning process does the answer arise from the work?
- (f) What by-product findings of value were made?
- (g) What suggestions or recommendations are made as a consequence of the work?
- (h) What relevant reports are already available?

In an article "Applying the Engineering Method to Report Writing,"⁷ Souther points out that most instructions for report writers deal with only the final product, and ignore the process by which it is evolved. Yet the *process* of preparing the report is the difficult phase for most writers.

He then discusses the "Engineering Method" of report preparation and gives a detailed check list for report preparation. Although the article refers to written reports, the organization of the information applies also to oral reports except for the sections which refer to the physical arrangement of portions of the manuscript. The speaker has only oral means for bringing out the relationships of sections.

Emphasis and Viewpoint

The foregoing plans for organization assume that the emphasis is to be on strictly factual reporting of technical information addressed to technical people or to people who want or need to have such technical facts. However, it may be that your talk will be to a club, school, or the monthly foremen's meeting, or to salesmen or customers. In these cases, the emphasis will be on explaining the significance of scientific facts to laymen, or telling them about the kind of work you and your fellow scientists and engineers do in industry. Or, the emphasis may be on use of a product, process or machine or on health and fire hazards in specific situations. Emphasis and viewpoint must be decided upon and kept in mind constantly while organizing the information to be presented.

Conversation

Organizing your facts and ideas for conversation is, of course, simpler than for a formal report. You'll say only a few sentences at a time and cover only a few

main points; but still good organization is important if your ideas are to get across.

Organization is nothing more than clear and orderly thinking. Acquire the habit of thinking in an analytical way about the work you're doing, about the things you're interested in, and about what you read and see. Practice forming appropriate headings for groups of these bits of information or, given the general headings, fit the various bits into their logical places. This training will prepare you to report extemporaneously on the work you're doing. Think and organize before and while you're talking.

Beginning and Ending

The introductory and closing units are especially important and require special treatment. The beginning "Tells 'em what you're going to tell 'em." It includes a statement of the scope of the report, furnishes the map of what's to be covered, the itinerary giving the main points to be visited. The form your introduction will take will vary widely according to the subject matter and purpose of your talk. It may be an outline of the talk, or an enumeration of principal topics, or it may be just a few simple introductory sentences. In any case, it should whet your listeners' interest and gain their attention as well as give them a preview to help them understand what you are going to say. You will erect signposts which you will refer to later, to keep your listeners on the trail as you describe the main points of interest.

The ending is equally important, because here your

listeners form their final impression. Here you "Tell 'em what you've told 'em." You summarize, and enumerate the principal points again, but this time in the light of the detailed explanation you gave in the main part of the talk, and thus emphasize their significance. Here is your last chance to make sure that your listeners understand the facts, or agree with your argument, or undertake the course of action you recommend. Include in the summary only what *has* been done. Whatever limitations the report may have, what was *not* done or could not be done, should be put in the introductory part.

The final sentences are the most important of all. Don't end like a slow leak. Have a specially interesting fact or argument for closing. All authorities agree that the end should be something your listeners will remember. Think of the verbal equivalent of turning loose a basket of pigeons.

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5. COMPOSITION FOR ORAL DELIVERY

Most of us are not equipped to use our language most effectively. There are complaints from industry that many graduate chemists and engineers can't present technical material well, either orally or in writing. Some universities have to give their freshmen special courses in English, covering things that should have been learned in grade and high schools, before the students can handle college work.

Complaints are loud and frequent about scientists' oral presentation of papers at scientific meetings.

This chapter will review the opinions of numerous experts in the field of technical expression. The emphasis will be on composition for *oral* delivery, although the rules of grammar and most of the techniques recommended for simple, lucid exposition apply equally to oral and written delivery. Obviously, a complete treatment of such rules and recommendations is beyond the scope of a chapter. A study of books and articles on composition is necessary. This chapter will touch on such things as the most frequent mistakes in oral reports, the commonest causes of ambiguity and a few suggestions for simplicity and clarity of expression.

More important than grammatical technicalities, however, is effective delivery. The oral delivery should be spontaneous. While you are talking, you should think about the ideas you want to express, not about rules of

grammar. The most important thing about composing for oral delivery is that it be spontaneous. The natural pauses and inflections and tempo when you are putting words together as you speak make a more effective delivery than woodenly reading grammatically perfect copy. When speaking we use more personal pronouns, contractions, and colloquialisms than when we write.

In order to use effective forms of expression and grammatical constructions spontaneously, you need to study, read and write until such expressions and constructions become a part of your thinking. That is why you should write your oral report, even though you are not going to read it word-for-word. While you are writing you *can* pause to think about rules of grammar and what you have read about composition. Thinking about the rules and suggestions and especially putting them to use as you write, improves your ability to put your thoughts into words when you speak impromptu.

Abstracting

Every report is an abstract boiled down from a great many facts, opinions or arguments. When you are asked or when you volunteer to tell about such seemingly simple things as fire, the weather, or how you feel, you can't possibly say everything that might be said. You must make an abstract. You say those things you think will interest your listener and are suitable to that particular occasion.

Include only essentials. Try to distinguish between what is *important* and what is merely *related*. When you're writing the preliminary draft of your formal oral

report, *do* include doubtful material. It will help you decide which things are most important. The unimportant things can be cut out when revising the manuscript.

Learn to abstract. Practice by picking out the essential points, the meat and gist of statements you hear, papers and books you read. You will need to write abstracts of what you read while preparing material for your report. When speaking impromptu you will need to abstract your *own thoughts*. Unfortunately, you can't go back and edit a long, rambling statement or unwise remark that has already been said.

Words

In order to make sentences, you first choose words. Use your *own* words, the ones that come to you naturally. They are the words you can pronounce. They will sound natural and will best convey your meaning and will impress the audience with your sincerity. "Speech-making" words will have the opposite effect. When a man stalks to the platform and says, "At this time . . . I feel that it is . . . uh-h-h eminently appropriate to announce . . .," the message that will be received by the audience is "I have put on my speaking britches, and I'm going to convince each of you that I am a very important and impressive character."

Use *spoken* English. Write your oral report as you would say it when telling it to a friend. Hegarty⁹ says "Write it to Joe," your friend who is sitting on the other side of your desk visiting with you. Tell him that you are stuck with an oral report. He asks what it's about.

Then tell him what you're going to say and write it down as you tell him.

People can tell when you are speaking naturally. An elderly friend of mine was telling about his hardships and dangers on a hunting trip when he was caught out in the woods in a severe blizzard. He added, "I nearly perished." Coming from him, the expression sounded perfectly natural and commonplace, even though "perish" is a "written" word. Another man returned from a hunting trip and announced, "I shot two lovely mallards." He was given the horse laugh.

Speaking naturally doesn't mean speaking carelessly or thoughtlessly. An inexact or ambiguous expression can confuse your listeners or, even worse, give them one idea when you mean another.

You may have trouble with certain common words, either in pronouncing them or in knowing their proper meaning and usage. Some words may get tangled up in your mind. Others may come out as a whistle or a lisp, when strained through your upper plate. For example, I have trouble with "instance" and "incident." I have to hesitate and decide which one to say and then concentrate on pronouncing it. Study your own speaking habits and avoid the troublesome words, although you might practice using them in informal conversations.

Prefer simple words, short words. Prefer Anglo-Saxon words to those having Latin roots. They are easier to say and, more important, they are easier to understand. When speaking to an important audience about a subject we think is important, most of us unconsciously tend to use "important" words. Judging from technical

reports, some authors never go anywhere, they proceed; they never get anything, they procure it; they never buy anything, they purchase it. Some chemists never stir a liquid, they agitate it; they never start anything, they inaugurate it; they never stop or end an experiment, they discontinue or terminate it.

Here are some other examples of long words and expressions with suggested shorter ones:^{9, 10, 11, 17, 21}

Accompany	go with
Accomplish	do
Accumulate	gather
Ameliorate	improve
Ascertain	find out
Demonstrate	show
Effectuate	carry out
Equivalent	equal
For the purpose of	for
Initial	first
In the nature of	like
In view of the fact of	because
Rehabilitate	restore
Remove	take off, or away
Subsequent	next
Utilize	use
With respect to	for, about

Long words aren't *bad* words. There is nothing *wrong* with the words listed above. There is just the simple fact that short words generally get your meaning across better, especially in oral reports.

Try for precision in your choice of words. Avoid vague and abstract words. Question each use of a word ending in -ion, -tion, -ing, -ment, -ent, -ance, -ence -ancy, -able,

-al. For example don't use vague words like "substantial," "operations," "circumstances," "conditions," "development," when you mean to make a *definite* statement. Find words which convey your exact meaning. To do that, you must *know* the meanings and usage of words. Again, make a habit of learning words and their meanings, and don't rely on the usage you hear in speeches and over the radio and especially on television. Consult good dictionaries and references.⁴ Sounding ridiculous is perhaps worse than having your meaning garbled, and it will certainly distract your listeners' attention.

Many words, in addition to their central meanings or denotations, show overtones or suggested meanings known as connotations which they have acquired through association. The speaker must be concerned with both denotations and connotations of the words he selects. In the following examples, the denotations are correct but unfortunate connotations appear:²

"A notice of the meeting went up in the elevator in the administration building."

"The noise made by the control mechanism constituted a sound reason for redesign."

"The safety cards were played up in the company newspaper."

Similarly one should avoid the use, in a single sentence, of a word employed twice with different meanings or of words of similar sound but of different meanings:

"The *solution* to the problem lay in heating the aqueous *solution*."

"It was *not* hard to screen out the *knotwood*."

Test the composition for euphony by reading it aloud. Watch for distracting rhymes, rhythms and cacophony.

"Data to date indicate." ²

"In order to get the degree which is normally desired, three passes through the solution and machine are required." ²

"Go get garbage at the gate."

"Sixty selenium cells."

Of course all sibilant and gutteral sounds can't be eliminated, the best you can do is minimize them. You must learn to enunciate the inevitable minimum. For the last example it may not be practical to say "Three score electrodes with photo-conductive films of element number thirty-four."

Sentences

Kerekes and Winfrey ¹² say that the word is to thought what the atom is to matter. In the same way, the sentence can be compared to a useful substance formed by the combination of different chemical elements. When a chemist synthesizes a new compound, he chooses the starting material and conditions for the reaction best suited to give a high yield of the desired substance. Then he recrystallizes or redistills the product to obtain a clear, pure, useful material. He deplores obtaining a sticky, amorphous mass as a reaction product. Yet sometimes a chemist will put on the market sentences that don't meet specifications for clarity.

The most common error in technical writing and

speaking is poor arrangement of words in sentences.²⁰ For oral reports, each sentence should be self-explanatory as it progresses, its meaning unfolding as you say it. Don't make your listeners wait until the end of a long sentence to find out what you are talking about unless you are speaking for rhetorical effect, attempting to influence people. Periodic sentences, which have essential elements at the end, are used effectively by orators. This chapter, however, is concerned mostly with exposition.

There should be only one basic idea in a sentence. Two or more related thoughts may be put into the same sentence if the basic idea is the relationship between the thoughts, but unrelated ideas should be in separate sentences.

Wood and Lane²³ (p. 54 ff.) describe the essentials of a good sentence. They say that an adequate vocabulary and a keen discrimination of the best meanings and proper uses of words are essential, but still more essential is the ability to arrange words properly in sentences that will convey clearly and forcefully the ideas to be expressed. Among the requisites are the choice of the best subject nominative, the determination of its proper place, the selection of an effective closing phrase or word, consistency of construction, relation of all parts of the sentence to the subject nominative, and continuity of thought. Proper order of statement is of primary importance, and related words and phrases should be kept together.

Beginning a sentence with the indirect construction "There is," "It is," usually multiplies the words and forces the subject of the sentence into an inferior place.

In the following examples, for the corrected construction, eliminate the italics and insert the words in parentheses:

"There are many other primary minerals containing phosphorus."

"It is the belief of the miners (believe) that the ground now worked may be a slide."

"There is considerable work in the literature which supplies supporting circumstantial evidence."

Before saying "It . . . that," "There . . . where," "There . . . -ing," "There . . . that," try to find a construction that will express your thought more forcefully and directly.

Choose a concrete noun for the subject and a strong verb for predicate. The use of "to be" leads to a weak and flabby construction when used as a principal verb indicating other than existence or location, especially if the verb idea is carried by an abstract noun.

"... but the experiment *was a complete failure* (failed completely)".

"... it *is of concern* also to (concerns) scientists themselves."

Similarly examine forms of *to have* and look for such verbs as *give, make, do, occur, cause, effect, bring about*, when used with abstract nouns which carry the verb idea.

"These developments *had a profound influence on* (profoundly influenced) Philadelphia's Main Line District."

“A considerable number of scientists also *gave careful consideration to* (considered carefully) the prospective working atmosphere in choosing a job.”

“...this *brought the end of* (ended) tolls.”

“*The exploration of* the region was *carried out* (explored) by Smith.”

“*Confirmation of* these reports cannot be *obtained* (confirmed).”

These sentences were corrected by using a concrete noun for the subject and changing one of the more or less abstract nouns to a verb.^{23, 37}

The active voice is usually preferred to the passive when making a definite statement.

“The analyst weighed the sample and dissolved it in hydrochloric acid.”

not

“The sample was weighed by the analyst and was dissolved in hydrochloric acid.”

The passive voice is used for describing experiments without the doer, when an impersonal attitude is desired and when emphasis is on the *actor* rather than the *action*.

“The solution was boiled and filtered.”

“The conductivity meter was read every hour.”

In spite of its admitted usefulness in some situations, the passive construction can be overworked. Its

improper use leads to wordy and indirect statements. It is difficult to describe action in the passive voice. The imperative mood is usually preferable to the passive construction for giving directions and describing analytical procedures.

“When the conductivity of the effluent reaches 20 micromhos, regenerate the cation exchange column. Open valves A and B, and pass hydrochloric acid through the column.”

Pronouns and Antecedents

Inasmuch as a pronoun is meaningful only in reference to the word or phrase for which it stands, the reference should be definite and unmistakably clear.

“The hardness gauge was used to test the alloy, but *it* was found to be unsatisfactory.” (Which was unsatisfactory, the gauge or the alloy?)

“The hardness gauge, which was later found to be unsatisfactory, was used to test the alloy.”

“The hardness gauge was used to test the alloy which was thus found to be unsatisfactory.”

Conjunctions

Many sentences contain more than one statement. The conjunctions joining the separate clauses should bring out the subordination between the statements. A group of several clauses loosely strung together with “and,” “but” or “so” or a series of simple sentences makes

dull listening and does not bring out the relative emphasis and shade of meaning that is intended.

“He found that the pH of the second batch was too low and examined the equipment and found a defective valve which caused the contamination.”

“After he found that the PH of the second batch was too low, he examined the equipment and found a defective valve which caused the contamination.”

“The corrosion contaminates the solution and the iron piping must be replaced with stainless steel so the cost will be higher.”

“Because the corrosion contaminates the solution, the iron piping must be replaced with stainless steel which costs more.”

“While” and “since” should be used only for temporal relationships.

“While I was taking a walk it started to rain.”

“Since I came in the house it has been clear.”

“While” should not be used indiscriminately for “and,” “but,” “whereas,” “although,” “notwithstanding,” “yet.” Such use may lead to ambiguity. For example, the sentence—

“While (meaning *although*) the output was more than 20 gallons per minute, a sample was taken every hour.”

will be understood to mean “During the time that the output was more than 20 gallons per minute, a sample was taken every hour.”

Similarly, "since" should not be used to mean "as," "inasmuch as," "because."

Word Order

One of the characteristics of the English language is the importance of word order for expression of meaning. Adverbs and prepositional phrases must be properly placed to convey the intended meaning. For example, each of the following sentences has a different meaning:

"It just doesn't happen."

"It doesn't just happen."

"At Plant Number Two it was reported that the punch press must be repaired."

"It was reported that the punch press at Plant Number Two must be repaired."

"It was reported that the punch press must be repaired at Plant Number Two."

Repetition and Parallelism

Avoid aimless repetition of the same word or words. Needless repeating, especially of overworked words like "data," "cases," "occurs," "then," "etc.", diverts the listeners' attention from the *thought* you're trying to convey to the *means* you're using to convey it.

Repetition is *properly* used to express a parallel relation of ideas. A sense for balance and symmetry calls for similarity in form when expressing the similarity in a series of ideas. To express a parallel relationship among

ideas, use the same word and word forms, and the same grammatical construction.

“The first column removes the cations from the raw water, the second column removes the acid, and the aerator removes the CO₂.”

“Dissolve the sample in acid, neutralize with ammonia, filter the solution and evaporate it to dryness.”

In the above examples, the important thing is the sequence, each step is of equal value, and is important only in its relation to the others. Therefore, don't look for variety in expression when there's no variety in the ideas to be expressed.

When the ideas you have to express are essentially a tabulation, use parallelism. Such occasions occur most frequently in the introduction, in the summary, in giving instructions, and in the conclusions and recommendations. In those places you will list a series of points to be covered, facts that have been established or things to be done.

Transitions

A transition is a word, phrase, sentence or paragraph that indicates the relationship between what has been said, what is being said and what will be said. Proper use of transitions is necessary for smooth continuity from one statement to another and to show the relationships and relative emphasis of the statements.

Without transitions:

“Stainless steel costs more than cast iron. Substituting stainless steel fittings for the cast iron fittings

eliminated replacement and upkeep expense. The overall operating cost of the process is lower. The quality of the product is better.”

With transitions:

“*Although* stainless steel costs more than cast iron, substituting stainless steel fittings for the cast iron fittings eliminated replacement and upkeep expense. *Consequently* the overall operating cost of the process is lower. *Furthermore*, the quality of the product is better.”

Without transitions:

“The repair work was hampered by the power failure. The maintenance department had the machine ready for operation at four o’clock.”

With transitions:

“The repair work was hampered by the power failure. *Nevertheless*, the maintenance department had the machine ready for operation at four o’clock.”

“*Nevertheless*” relates the second sentence to the previous one and brings out the idea that the repair was made promptly in spite of difficulties.

“*Consequently*” and “*Therefore*” introduce a conclusion and establish a cause-and-effect relationship. “*Moreover*” and “*furthermore*” indicate that more-of-the-same will follow. “*Although*” indicates that what immediately follows will be qualified, refuted or counterbalanced. “*However*” suggests that a different point of view will be introduced, or an exception noted.

Some other frequently used transitional words and phrases are:

on the other hand	in addition
in spite of	in comparison
also	finally
now	next
so	then
as a result	hence
of course	on the one hand
for example	on the other hand
besides	in consequence

Transitional sentences and paragraphs are used in the same way as transitional words and phrases and are used to clarify the organization of the ideas in the report. The transitional passages should indicate the direction the discussion is taking and should help the listener keep the main topics of the report in proper perspective.

The following transitional sentences connect what has gone before with what will follow:

“However, even though this alloy is resistant to corrosion, its hardness introduces some manufacturing problems.”

“Following those preliminary calculations a pilot plant study was started.”

“To meet this unexpected difficulty, the laboratory started a new series of tests.”

Sentence Length

Vary the length. Short sentences and long sentences each serve a special purpose, but the desired effect de-

pends on contrast in sentence length. An uninterrupted series of sentences of the same length becomes monotonous and makes dull reading or listening.

A short sentence packs a punch. The effect of the punch will be dulled, however, if the sentence was preceded by other short staccato sentences. A crisp, short sentence makes a good opening or closing, as first and last impressions are important.

The various "readability" formulas put a premium on short sentences.

However, this shouldn't lead to an undiscriminating passion for writing nothing but short sentences. Sentence length is not the only factor in the readability formulas, and "readability" isn't the only thing to think about when writing.

Sometimes a long sentence will bring out more clearly than several short ones the relations between several ideas. A long sentence is sometimes necessary to express a complicated idea. Emphasis, contrast and conclusions often may be effectively expressed by the combination of a long sentence with a very short one before or after.

The admonitions about sentence length refer to the *average* number of words in each sentence. In material written for educated adults, the sentences may average between twenty and thirty words. In this range are articles in *The New York Times* and in some technical journals. In Lincoln's *Gettysburg Address* the average sentence length is twenty-six words, and the last sentence contains eighty-two words.

Style

Style is verbal personality. We recognize the over-all impression of a person's personality without being able to enumerate all the individual traits that make up the whole. Similarly, we can't precisely define literary style. We can specify what the overall effect should be, but we can list only *some* of the individual things that will contribute to that effect.

The style for technical reports should be lucid, simple, direct, concrete, objective. Oral reports are less formal than written reports and can be objective without being coldly impersonal. The first personal pronouns are proper when the speaker is relating his own opinions or experiences: "I visited three plants that use our equipment and examined . . ."

The style should be smooth so that each idea flows into the stream of thought imperceptibly. The listener's attention should be on the substance of what you are saying, not on how you are saying it. Attempting to be "literary" and using flowery language will distract the listener's attention, and will also sound just plain silly. However, that doesn't mean being deadly dull. Don't be afraid to be original. An occasional flippancy or irrelevancy or vivid expression may be needed to arouse the listener's interest or to point out a sharp contrast or to refute an unrecognized absurdity. I don't know of any set of rules that will tell how to do all those things. Even if there were such rules, they would be different for each person. Nothing can take the place of your own good judgment, common sense, and original way of thinking.

The most important thing to think about is the audience, the *people* you will talk to. Who are they? What are their interests and needs? What is the purpose of your talk, to inform, to instruct, to convince? Scientists and engineers are frequently told to adopt the "You-attitude" in their writing and speaking. We should certainly try to do so, but we must realize that the proper "You-approach" is more sophisticated than using the pronoun "you" frequently, and "putting-oneself-in-the-position-of-the-listener." Indiscriminate use of "you" is apt to sound patronizing or fawning, or may become irritating. Say to an audience "When you hear my list of reasons you will agree that . . ." and the audience is apt to think "Says *you!*"

The "You-approach" is the choice and arrangement of the subject matter and the adoption of a style that is suited to the needs and tastes of that particular audience. It is just ordinary courtesy and common sense. Assume that the listeners are intelligent but uninformed about the subject matter of your talk. In case of doubt, overestimate their intelligence and underestimate their knowledge of the subject.

The point of view and emphasis must be adjusted to the audience. A report to the board of directors or stockholders about the development of a new product would emphasize cost and sales possibilities to show that the company can make a profit marketing the product. A report on the same development to the technical staff of the company or to a scientific society meeting would be an objective exposition of materials and methods used, new facts discovered, figures and charts giving quantitative results. The talk to a luncheon club would include

what the new product will do for the purchaser, what its significance is to the listeners,—make the wash whiter, or more miles per gallon—less drudgery for the house-wife, or economy for the motorist, a new factory building, more people employed. The object of a talk may require still other considerations. The object may be to amuse, to persuade or to inspire, it may be to rebuke or even to annoy and shock as a means to an end.

Brevity can have negative virtue. If it is lacking, the composition is probably hard to understand; but its presence alone does not guarantee comprehension. Work for brevity by eliminating *unnecessary* words, not by packing the ideas too close together:

"It can readily be seen from the foregoing (shows) that . . ."

"It is always necessary that acid (must) be added."

Avoid trite expressions and you will automatically eliminate unnecessary words:

"I'd like to take this opportunity . . ."

"If I may be permitted to say . . ."

"I want to say one more little thing . . ."

"May I suggest in passing . . ."

Straining for brevity risks ambiguity. Newspaper headlines are extreme examples:

"Three Iowans Wreck Victims"

"Governor Calls Drought Talk"

This ambiguity results from elimination of articles and connectives, use of verb forms as nouns, too many noun

modifiers, and use of words which in identical form constitute two different parts of speech.

The object of talk is to create an effect in the listener's mind. Think about the listeners, think about the effect you want to create, and then consider what kind of words and what sort of arrangements of words the listeners' receiving apparatus is tuned to receive.

Beginning and Ending

Some aspects of beginnings and endings and their importance are discussed in the chapters on "Organization" and "Talking Science to Laymen," and in several places in this chapter. The purpose of the beginning, or "introduction," is to gain attention, then interest and to lead to the substance of your talk. For most technical oral reports to a technical audience, starting with a story just to get a laugh, is a waste of time. An anecdote is appropriate if it vividly illustrates some aspect of your discussion. For lay groups and most luncheon and dinner meetings, anecdotes are almost a necessity. Anecdotes and stories are effective for warming up or relaxing an audience and for illustrating scientific facts and principles to laymen.

A startling statement can be an effective beginning on some occasions. A friend * told me that he starts one talk with "Scientific research is of no value whatever . . ." Then he tells his shocked listeners ". . . until it has been effectively communicated to those who can use it." That opening gets the attention of his listeners and tells them what is to be his main topic.

* James O. Howe, Whiting, Ind.

Similarly, the ending should be composed to fit the subject and the occasion. For a technical report, the ending should be a succinctly stated conclusion or a summary of the facts. Some reports should end with a recommendation, others with the most forceful reason for a proposed course of action. In any case, the ending should be a climax, and a suitable transition from sound to silence.

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6. DELIVERY: PERSONAL TECHNIQUES— FORMALLY PREPARED TALKS

A talk can be more effective than an impersonal array of printed words. When you speak, your personality and conviction will help get your ideas across. You can watch the audience and if they seem not to understand, you can repeat the point in different words. You can help the audience share your enthusiasm.

First you must be *heard*. Whether you are speaking to one person or to a thousand, your voice must reach the listener. Speak up so people can hear. Keep your hand away from your mouth. Speak into the microphone if there is one.

Next you must be *understood*. The audience must know what words you are trying to say. Enunciate distinctly. Pronounce words correctly.

Finally, you must be *comprehended*. The audience must grasp your intended meaning. The words the listeners hear and understand must be remembered in sequence until the idea is expressed. You must keep the listeners' attention by keeping them interested and by avoiding distractions.

The next thing is *how to do it*. Most of us do not have the opportunity or ambition to take a formal course of training in speech. However, all of us can learn a few simple things to do and not to do that will make our talk easier to understand. The techniques are both mental

and physical: how to cope with our minds, bodies and the physical surroundings.

You will probably be apprehensive and jittery when you stand up to speak. If you are, you will be in distinguished company. It has been reported that many famous people were nervous when they spoke in public, including George Washington, Abraham Lincoln, William Jennings Bryan, and Winston Churchill.

A little apprehension is a good thing. It means you are keyed up, on edge, keen to do a good job. Admit to yourself that you are scared, and resolve that you are going to speak well. Your jitters will disappear after you get under way.

Thinking

You have a thorough knowledge of the subject. You have made thorough preparation. You have a sincere desire to get your ideas across. Therefore, you will think only about your subject and talk conversationally to each member of the audience as if you were talking to him alone on a street corner.

Your demeanor communicates as well as your words. Smile; be friendly, but not effusive. Act as if you enjoy making the talk, and you and the audience *will* enjoy it. If you slouch and mumble, the audience will assume that your ideas are as sloppy as you are. If you apologize for your inexperience in speaking or for inadequate preparation, the audience will assume that maybe you aren't going to have much to say after all. Be modest but not apologetic. Be assured but not arrogant. Don't try to *act* assured, *be* assured. The audience won't be as

critical as you think. They are there because they want to hear what you have to say.

Actions

Good posture will help your composure. The position of your body and tenseness in your muscles affect your mental attitude. Stand erect, head up, breathe deeply, be relaxed physically and alert mentally. Try especially to relax your muscles. Tension makes your movements, breathing and speaking stiff and strained. Keep your hands away from your face and mouth. Keep your head up; don't speak or read from a manuscript with your chin down in your collar. Your motions and gestures should be easy and natural; don't stand like a wooden Indian. And don't go to the other extreme and roam all over the platform.

SPEAKING

Enunciate each syllable of each word. Use your tongue and lips, and open your mouth wider than you usually do. Give special attention to syllables at the end of words and to words at the end of sentences. Don't slur your words. Television announcers urge us to get our "cloze reely wite." At a symposium on safety a speaker said "... n-n-n-a-void'ble accid'nt." I'll go to my grave not knowing whether he meant "... *an* avoidable accident" or "... *un*avoidable accident." You can speak precisely without sounding affected. Listeners appreciate a speaker they can understand. At another technical session, one speaker was afflicted with a marked hoarseness

from a recent illness. He was obviously distressed and probably thought his talk would be a colossal flop. It was the clearest presentation of the whole meeting because he *had* to speak carefully. The audience understood every word and every syllable because he made an effort to enunciate clearly.*

Pronunciation ^{4, 8, 11}

Of course we look up the pronunciation of words we don't know. But when we make a speech we don't use many words we don't know. The trouble comes from the common words that we have been mispronouncing for years without realizing it. Such mistakes are:

Putting the accent on the wrong syllable:

im-PO-tent instead of IM-po-tent

com-PAR-a-b'l instead of COM-pa-ra-b'l

Failing to sound certain letters:

lenth and *strenth* instead of *lenGth* and *strenGth*.

Giving a letter or syllable the wrong sound:

orgy: *g* as in *go*, instead of *as* in *gem*

guarantee: sounding "a" as in *far* (should sound like "a" in *cat*)

Transposing letters:

bronchial: *bron-i-k'l* instead of *bronk-ee-'l*

larynx: *lahr-nix* instead of *lar-eenx*

Adding extra syllables:

drowned: *drown-ded* instead of *drownd*

athlete: *ath-a-leet* instead of *ath-leet*

* W. K. Seward, Niagara Falls, N. Y., Am. Chem. Soc. Meeting, April 7, 1955.

The accent should be on the capitalized syllables of these words:

COMparable	inEXplicable
PREFERable	APPlicably
AMicable	FORmidable
HOSpitable	REPutable
inHOSpitable	DESpicable
ADMirable	INFamous
LAMENTable	INfluence
IMPious	AFFluence
disTRIBute	muNICipal
INtegral	roBUST
INTRicate	DIRigible
aCumen	INTERested
cuRAtor	INTEResting
tesTATOR	CONtract (noun)
CONversant	conTRACT (verb)
EXplicable	conTRACTor

Avoid extra syllables:

preventive	pre-VEN-tive	not pre-VEN-ta-tive
mischievous	MISS-chi-vus	not miss-CHEE-vee-us
grievous	GREE-vus	not GREE-vee-us
elm	ELM (1 syllable)	not Ell-um
kiln	KIL or KILN (1 syllable)	not KILL-un
athletic	ath-LET-ic	not ath-a-LET-ic
parliament	PAR-li-ment	not PAR-li-a-ment
orient	O-ri-ent	not O-ri-en-tate
mountainous	MOUN-ten-us	not MOUN-ta-nee-ous

In these words the "g" is soft as in *gem*:

orgy
gesture (last syllable *tur*, not *chur*)

gibberish

turgid

gibe

longevity

In these words, *g* has the sound of *s* in *pleasure*:

corsage

prestige

cortege

Pronounce syllables correctly:

perspiration	PER-spi-RAY-shun	not press-pir-AY-shun
prescription	pre-SKRIP-shun	not per-SKRIP-shun
percolator	per-ko-LAY-ter (no U in the sec- ond syllable)	not PUR-kyoo-lay-ter
chaise longue	shaze-long	not -lounge
Moscow	Mos-co (second syllable rhymes with <i>hoe</i> , not <i>cow</i>)	
height	(rhymes with <i>light</i>)	
finally	(three syllables)	
Italian	(first syllable is <i>It</i> , not <i>Eye</i>)	
introduce	(not <i>interduce</i> or <i>innerduce</i>)	
inter	(not <i>inner</i>)	
just	(not <i>jist</i>)	
can	(not <i>kin</i>)	
for	(not <i>fer</i>)	
sherbet	(not <i>sherbeRt</i>)	
hundred	(not <i>hunnert</i>)	

In these words, *ch* is pronounced as *k*:

chiROPodist
machiNAtions
CHAos
archiPELago

In these words the capital letters should be sounded (not necessarily accented):

aCcessory	asKed
suCcinCt	piCture
aCcept	probaBly
aCcide	ruIn (2 syllables)
aCcelerator	poEm (2 syllables)
libRary	recoGnize
FebRuary	particUlar
wiDth	figUre
goVerNment	regUlar
gEography	accUrate
Eleven	manUfacture
prOduce	kepT
amPHitheater (not amp-)	finD
grinD	carAmel

Dictionaries giving pronunciations of technical terms are listed at the end of the chapter among the references.

Voice

The sound of our voices can attract or repel our listeners. Most of us are not gifted with naturally pleasing voices so we must do the best we can with what we have.

Proper posture and motions can improve the sound of our voices.

Think of making your mouth, throat and lungs an open cavern so the sound can reverberate and come out freely. If your throat muscles are tense, the passageway is narrowed, the vocal chords are tighter, the pitch of your voice will be higher and the sound pinched and harsh.

We can eliminate slovenly speaking habits. And above all, we can put our personalities and feelings into what we say and how we say it so the listeners will pay attention to our ideas and not to the sounds that express them.

Keep your muscles relaxed, chin up, mouth and throat open so the sound can come out. Talk smoothly. Try to speak naturally, conversationally. Don't speak in a monotone. Vary the pitch and loudness, modulate to help express your meaning and your feelings. Such inflections are necessary for verbal punctuation and to keep the listeners' interest. You can indicate different shades of interest and feeling by emphasizing different words in such a sentence as:

“Do you think he really did that?”

Proper inflection is absolutely necessary to indicate which of these meanings is intended:

“The analyst,” said the supervisor, “made a mistake.”

The analyst said the supervisor made a mistake.

You certainly wouldn't compose a sentence like the first one for oral delivery, but you may want to quote or read such a sentence when speaking.

When you speak publicly, speak as you do privately. If you look out the laboratory window on a fine Spring

morning and see something to report to your colleagues, you wouldn't deliver your report this way:

“uh-h-h—hey-fellows-look-at-the-ee-uh-h-h—blond-crossing-the-street-oh-boy-isn’t-she-uh-h-h-beaut-wow—”

Rate

The average rate of speaking is about one hundred and thirty-five words a minute. The rate for reading aloud is about one hundred and fifty words a minute, and for speaking without notes about one hundred. Less than ninety words a minute will annoy the audience; more than one hundred and sixty is too fast to follow easily. Speak at whatever rate, within the acceptable range, is easiest for you. Also, you must vary the rate to make it consistent with the modulation of the tone and timbre of your voice.

Permit a pause occasionally as part of the verbal punctuation but don't fill up each pause with “—er-r-r-uh-h-h.” Let the air be empty of sound for an instant now and then. It's natural to pause when you have finished expressing a thought or idea before going on to the next. During that pause your mind recalls the next idea and then you express it. The more closely related the ideas are, the shorter the pause. When a new line of thought or new series of ideas is to be introduced, it takes a little longer for your mind to arrange them. Also, the longer pause prepares your audience for the new ideas. Arrangement of printed text in paragraphs and sections helps the reader understand the relationships between groups of ideas. When you speak, your pauses are the

oral equivalents of periods and indentations for paragraphs.

You will need to speak louder than you think is necessary when you are talking to a group. To get an idea of how loud to speak, look at the person who is farthest from you, imagine there is no one else in the room, then talk to him. Don't yell. Get the necessary volume of sound by breathing deeply, holding your head up and opening your mouth and throat, get a push *behind* it. Avoid trying to *squeeze* out more sound. Don't tighten the muscles in your diaphragm and throat.

PHYSICAL ARRANGEMENTS

Avoid Distractions

Don't do or say anything that will attract the listeners' attention away from the ideas you are expressing. Your attire should be neat but inconspicuous. Avoid distracting mannerisms such as repeatedly putting on and taking off your spectacles, waving the manuscript, fumbling with notes, pulling at your clothing, leaning on the pointer. Try to recognize and curb your verbal mannerisms, overuse of pet words and expressions, such as—"I mean—," "—that is—," "—that is to say—," "—in other words—."

Show visual aids and exhibits *only* while you are discussing them. Distribute samples and printed matter *after* the talk. If you want to tell about samples while each listener is looking at one, this should be the last step in your presentation. Otherwise, some people will keep on studying the sample or will talk to their neighbors about it when you go on to another topic. Also,

passing out the samples is likely to cause confusion and delay, especially if the room is crowded.

Pointers are a source of distraction. After using the pointer, put it aside at once. Put the wood pointer where it can't fall on the floor. Turn off the electric pointer. A bright spot of light darting over the walls and ceiling will certainly take peoples' minds off what you are saying. Don't gesticulate with the wood pointer or use it as a leaning post.

Mechanical Aids

Inspect the meeting room in advance. Check the arrangements for showing your slides and other displays. See that the screen and projector are in order, that the house lights can be dimmed and that a projectionist will be on hand. Arrange to have a pointer and chalk and eraser for the blackboard.

Find out in advance what is the "pick up range" of the microphone, and then keep within that distance. Don't look at the microphone. Look over the microphone at the audience. Keep your mouth the proper distance from the microphone, but talk to the audience. The microphone should be placed so that it is within range when you point to the screen or blackboard. If you must step out of range to point, don't speak until you are back. Have someone posted in the back of the room to signal if he can't hear.

Don't Talk to the Screen or Blackboard

Face the audience. If you must use the blackboard to illustrate an equation or diagram, face the audience and

discuss it *after* you have written it. When a new slide is thrown on the screen, glance at it to see that it is the right one, then face the audience and discuss it, if necessary; or pause and let them read it.

DON'T READ YOUR SLIDES TO THE AUDIENCE

Time

Keep track of the time and be prepared to summarize and close when the allotted time is up. Time yourself when you practice your talk, and remember that it will take longer to deliver before the audience than it took in practice. Also, the chairman's introduction and the time for you to reach the platform and then retire must come out of your allotted time. Plan your talk so that it takes several minutes less in practice than the time allotted to you.

Notes or Manuscript

It is best to deliver your talk extemporaneously from carefully prepared notes. You may use the manuscript as you would notes, but don't read it. When you read, your attention is likely to be on each word as it comes along, rather than on the thought embodied in the whole group of words that make up the sentence. Then your delivery will be mechanical and lifeless. Nor should you try to memorize your manuscript word-for-word.

If you know your subject thoroughly and have gone over your notes or manuscript again and again, you will be able to speak extemporaneously and merely glance at

your notes occasionally. You won't need to use the exact wording in your manuscript if you will use slightly different wording each time you practice. Your presentation will be more natural and convincing if you put your thoughts into words as you speak. You will have more animation and keep in closer contact with your audience.

It is permissible occasionally to read a manuscript. When you are going to read, be sure the manuscript is written in oral English, written the way you speak. Practice reading it until you are so familiar with it you can think of sentences and paragraphs as units and give proper inflections, pauses and changes in pace. While you are reading, hold your head up and look at the audience frequently. Don't hold the manuscript in front of your face.

When reading numerical values, don't give more than two or three significant figures. If the item is \$1,263,481.71, say "A little over a million and a quarter dollars." That will give the audience a more accurate idea of the amount than saying "One million two hundred and sixty-three thousand four hundred and eighty-one dollars and seventy-one cents." If you read every digit, the audience will remember "-seventy-one cents" and "-million-"; maybe some will remember "One million-."

A long string of digits is not only impossible to comprehend aurally but is absurd from the viewpoint of significance. If dollars were inches, \$1,263,481.71 would be almost twenty miles and the one cent at the tail end would be one hundredth of an inch, a little more than the thickness of a calling card. Take a deep breath and

your belt buckle will be several "cents" closer to Keokuk, twenty miles down the river.

It is not enough just to point your eyes at the audience while you speak. Look at the *individuals*. If they seem to be straining to hear, speak louder. If they look puzzled, pause and summarize or repeat the point in simpler language. Try to think of an example within the listeners' experience. If they are inattentive, the impulse is to speak louder and faster, but don't do it. You can't ram it down their throats. Don't repeat. If they are inattentive and bored, the reason may be that you have been repeating too much; they got the point before you finally finished telling about it. Again, pause. An abrupt halt will regain attention. Think of a vivid expression or lively example to regain their interest. If possible, use a personal example or anecdote, what you or some other person did or could do. At least start talking about something new. Try harder to vary the pace, put more animation into your speaking.

Practice

You can't learn to swim or make speeches by reading books. Dive in and try to apply what you have read. The water is awfully cold when you first jump in, but it seems warmer after you start swimming. Speak up whenever you have a chance to do so. Get used to saying a few words in front of people. Get up in meetings and say what you have to say. In your everyday conversations practice the recommended techniques: chin up, hands away from face, mouth and throat open, enunciate distinctly, speak carefully and thoughtfully.

The techniques described in this chapter seem absurdly simple. One would think they are things that everybody knows, yet many people don't do them. When we speak we hear only the words that our minds compose; we don't hear how the mumbled words sound to someone else who doesn't know in advance what we mean. The author once took part in a formal discussion session at a chemical society meeting. The discussion was recorded and a transcription was sent to each speaker for editing. On receiving his transcript this speaker suffered bafflement, frustration and severe shock to the ego. His laboratory colleagues said the transcript read like Gertrude Stein. It would have been much easier to write the piece anew than it was to edit the transcript and try to figure what actually was said. That sort of experience is more convincing than the admonitions of friends that our talk is hard to understand. As part of the preparation for your next talk, record it, then listen back several days later.

Practice. Ask your wife and friends to listen and suggest improvements as you practice delivering your next talk. The more you practice, the easier the talk will be. The more talks you give, the easier the next one will be.

OCCUPATIONAL HAZARD

Platformitis: An allergic reaction. Contact with a rostrum or even the sight of microphone or audience causes the patient to break out in a rash of polysyllabic circumlocution. Susceptibility to attack is aggravated by chronic edema of the ego.

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16. Villalon, Luis J. A., "So You're Going to Make a Speech," *Research and Engineering*, 2, No. 12, 14-15, 31-2 (1956).
Some guides to effective speaking.

Dictionaries Giving Pronunciation of Technical Terms

Consult the preface for key to pronunciation.

(Thanks to Robert W. Voorhees, Funk and Wagnalls Co., New York, for most of these references)

Biological sciences:

- 16a. "A Dictionary of Scientific Terms." By I. F. and W. D. Henderson, 3rd ed., revised by J. H. Kenneth, D. Van Nostrand, New York, 383 pp., 1939.
Biology, botany, zoology, anatomy, cytology, embryology, physiology.
See Hackh and Grant, below.

Chemistry

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Chemistry, physics, astrophysics, mineralogy, pharmacy, agriculture, biology.

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Also consult the unabridged dictionaries, Funk & Wagnalls, Merriam-Webster, Oxford English Dictionary (and Supplement), H. C. Wyld's Universal English Dictionary, for valuable hints.

7. DELIVERY: PERSONAL TECHNIQUES— INFORMAL AND IMPROMPTU SPEAKING

In the previous chapter most of the discussion concerned the presentation of a formal oral report to an audience. Although most of your talking is informal and impromptu, the suggestions given in that chapter apply whenever and wherever you talk. You will always use the techniques that enable you to be heard, understood and comprehended. This chapter will cover some special applications and additional techniques for situations calling for impromptu speaking.

You go through the same steps as outlined in previous chapters: gather information, organize, compose, deliver. For the situations described in this chapter the steps are short and simple. The dominant factor is face-to-face *exchange* of information. You have the advantage of "feedback." You can adjust your approach to the developing conditions of the conversation or conference.

You gather additional information from what the other people say and do. You organize the facts and ideas that you decide are appropriate. If the other person is ill at ease, or apathetic or hostile, your next remark will state your ideas or facts in a manner that is reassuring, or startling, or conciliatory. If your own

feelings are involved—annoyance, elation, apprehension—you should try to recognize this, and confine your thoughts and remarks to the intellectual aspects of the discussion. You can direct your statements more specifically to the interests and experience of the listener when speaking to one or a few people in conversations and conferences than when speaking formally to dozens.

So although most of the general principles discussed in previous chapters are still valid for this chapter's special application, there are additional techniques specifically applicable here.

Person-to-Person

In conversations, deliberate before answering, especially when arguing. Your answer will be better composed and better received. The person you are talking with will know that you have listened to his statement and considered it. Therefore, he will be more inclined to hear and consider your reply. If you bounce back an answer without apparent consideration of the other person's remark, it will appear that you are merely stubbornly repeating your prejudices. It isn't necessary to go into a profound study, but pause at least an instant. Be alert and observing. You *do* want to know what the other fellow says. Also, the tone of his voice and subtle actions will help you compose your next remark.

When you are explaining a new plan, or product, and want the other person to adopt it or take some action about it, let *him* figure out some of the advantages. Don't recite in detail every conceivable aspect of the idea. The other person has already thought of some of them and

is getting fed up. By this time he is trying to think of disadvantages. None of us likes to swallow whole whatever is handed to us. Our ego gets into the act. We want to adopt a plan or product because *we* helped figure out what a good idea it is.

Introduce the description of the plan or product by telling the other person you have what you think is a good idea and want to get his suggestions. Then tell first the desirable results that the plan will accomplish. Tell it in terms of the other person's experience and personal interests. Then follow that up with a description of the plan or product and the principal supporting facts or arguments that are not obvious from the preliminary statement or from examination of the product. Tell it briefly. Ask the other person what he thinks of one or another of the points. Call attention to an apparent disadvantage, one that might be refuted or compensated by further consideration of other advantages of the plan. The other person will probably see the compensating advantages, and will perhaps suggest others. Now it has become his plan too.

Telephone Manners

Your voice is the only contact your telephone visitor has with you. He can't see your lips forming words; he must get his understanding only from whatever sounds are transmitted, and the telephone is not a high-fidelity instrument. You must speak with your mouth close to the transmitter and make a special effort to speak distinctly. Your visitor can't see your smile of pleasure when you receive his call. He can't see your look of satisfac-

tion or of consternation or regret when you hear his story. When talking face-to-face, a nod of understanding may be sufficient. But when talking over the telephone you must put those and other feelings into words and into your voice.

Other courtesies are necessary in telephone conversations as in talking face-to-face. When you make a phone call and someone answers, identify yourself at once, "This is John Smith, may I speak to Mr. Jones, please?" When you bring another person to his telephone you are his guest. You are speaking in his house or in his office. When you call in person at a man's house or office, you don't demand of your host, "Who are you?" When you make a phone call if your first words are "Who is this?", you may deservedly get in return a frosty "Whom are you calling?" The rest of the conversation will be strained.

Extraneous sounds are transmitted in addition to your voice. Slamming the receiver back into place when you have completed a call is especially unpleasant to the person on the other end of the line. When you take your departure from a house or office you close the door carefully so as not to slam it. When talking to a person you don't cough into his face, nor do you chew a mouthful of food or a cigar. When using the telephone you observe the same courtesies you practice when you are guest or host in person.

Don't continue a discussion or dictation after picking up the receiver to answer a call. When you admit a guest to your house or office you don't ignore him for a few minutes while you continue a private conversation. Neither do you get up and walk away from a guest with a curt, "Wait a minute." If you must leave the telephone

to get information or for any other reason, explain why, ask the other person's indulgence, or offer to call back. Finally, let the person who made the call end it. You don't know that he has completed his message until he says so. At your house or office you don't put on your hat and coat and walk out on a guest.

INDUSTRIAL COMMUNICATIONS

With Outsiders

If you work for an industrial or other organization, to an outsider you *are* that organization when you talk business with him in person or over the telephone. Your company's offices or factory may cover acres, employ thousands, make products known all over the world—yet you are the only contact that outsider has with the company while he is talking with you. What you say and do will profoundly influence his opinion of your company. That contact gives you an opportunity to impress this person with your company's courtesy and efficiency more effectively than could be done through letters and advertisements. If he has a grievance, there are more things you can't say to him than things you can. You can't tell him his complaint is unreasonable, and to go crawl back under his rock. You can't tell him it isn't *your* fault the trouble happened. Maybe the only thing you can tell him is that you're sorry and the company wants to see that the cause of the trouble is found and corrected. But the important thing is *how* you say it. You must let him know that the company is *glad* he reported the trouble so it can be corrected. Let him tell his whole story, get all the

details, let him get rid of all his resentment. By your actions and tone of voice as well as by your words, convince him of your sincerity.

A man with a grievance offers a special opportunity. Your company has many *passive* friends, customers who never had any trouble and take the company for granted. But you will make an *active* friend when you correct the man's grievance and give him a little more than he expected. Later he may admit that he was a little unreasonable, and he will not forget your patience and courtesy. At luncheon tables, in smoking rooms and club cars when your company is mentioned he will have a good word to say for it.

Within

It has been said that upward in the organization hierarchy, we "have communications;" downward, we "tell." Unfortunately that is true too often and is responsible for misunderstanding and lack of confidence due to inadequate communication. Try to overcome the barriers and build bridges to effective two-way communication in *both* directions. First, think of the other person as an individual, not as a mark, up or down, on the organization chart, although you can't forget the nature of your responsibility to that individual. His hopes, fears and aspirations are fundamentally the same as your own. When talking with him think of how *you* feel when you are in his relative position in upward or downward communication.

Employees^{1, 3}

To your subordinates, *you* are the company when you talk with them on the job. That is a responsibility. It is also a barrier to free communication from them to you which you must recognize and you must help them past that barrier. If you are going to *tell* effectively, you must also *hear* effectively.

When introducing new employees, giving instruction on the job or on safety, giving praise, corrections or reprimands, the employee must understand what you mean, your statement or request must be accepted, and it must be remembered. Be sure to tell *why*, and what it means to *them* and to *you*.

Consider five points when talking to subordinates. (1) Use the universal principle, *Speak the other fellow's language*. The words and examples used in explanations must be within the listener's intimate experience: he must understand exactly what you mean. (2) *In any speech situation never emphasize more than one item*. In giving instruction or correction, take up just one idea at a time. Don't wait until a lot of things have piled up and then try to cover them all at once. (3) *Dramatize your example as a memory device*. An apt example will help the other person understand what you are talking about, it will make your request seem reasonable, and it will help him remember what you said. (4) *Master the use of praise*. Don't ignore people until they do something wrong. People appreciate recognition and react accordingly. They will try to live up to whatever reputation you give them. Sometimes you may have to look hard and long to find something to praise, but it may be

needed to lift a person out of a slump. (5) *Don't mix praise with censure.* If you first praise a person every time you have a correction to make, he will soon quit hearing the praise. Then when you want to give him a genuine commendation he won't be listening, he'll think "OH-oh! What's wrong now?"

Colleagues

You must get along with the people you work with at the same level, those in the same department and those similarly situated in other departments. Each of us should do his part to prevent building up the atmosphere of suspicion, petty jealousy and backbiting found in some organizations. Your talk with your colleagues should be the same as with your subordinates and your boss. The difference is that your colleagues don't have to listen to or heed what you say. Therefore, when you have a suggestion or idea you want adopted you must make it interesting, and include in your telling of it what it means to them.

Include recognition of any help received from your colleagues when you report the completion of a project to your boss or to anyone else. Before you propose a change or new procedure, talk it over with your opposite number in any department that will be affected. Enlist his cooperation. Make it a mutual project. Avoid going over his head because he won't like it if your plan, that affects him, is adopted or brought to his attention from higher authority before hearing from you. Your relations with him will be strained and your capacity to function

effectively in the organization will be impaired by just that much.

When you propose a plan or a change, one of the first things to do is dispel the basic and universal fear of the unknown. We are all suspicious of what we don't understand. We all wonder how a change will affect us, our job, our relative position and standing. Clarifying those points, directly or by implication, is sometimes more important than telling the facts, if your plan is to be accepted.

The Boss

Don't let your boss be surprised. Keep him informed so he won't hear things about you and your work from other sources. You tell him first. Give him periodic progress reports on long-term projects. Tell him that an assignment will or will not be completed on schedule. Tell him about unexpected delays and deviations from approved procedure. Tell him about anticipated problems. If you try to conceal a boner, you are adding a more serious mistake to the first one. You will also report new ideas and suggestions and perhaps some gripes of your own. He wants to know about your gripes, if you have any. He is interested not only in work-centered matters but also in how you and the people under your supervision feel. What are the feelings and attitudes of you and your people toward other departments, toward the company and its various policies, especially about recent changes and proposed changes? Report gossip and rumor sparingly, if at all, and only those matters that seem to require some attention. Don't hesitate to report perti-

nent information just because it happens to be unpleasant. Finally, and above all, don't by-pass your immediate superior and take things up with higher authority except in an emergency.

When you have something to tell, BE PREPARED. First, of course, assemble all the facts. Arrange them in their proper relationship to one another. Distinguish facts from inferences and conclusions. However, facts alone are not enough. They don't speak for themselves. Your boss is busy. There are dozens of things distracting his attention away from you: his phone rings; his secretary brings in correspondence and reports; his desk is covered with things he wants to get at. Your first dozen words must tell the gist and significance of what you have to say. Your first sentence must interest him and give him a reason for wanting to listen. If you start with a long, historical introduction and build up, and proceed logically and laboriously from step to step, the boss may think, "There he goes, still harping on that plan we tried out two years ago." Then his mind will be on other things before you get to the point.

After you have recited the most important or the most spectacular advantage, the next step in your plan of presentation is to tell what is new and significant about your proposal. Tell how it differs from any similar previous proposal.

Now it's time to tell the facts. Tell them in terms of the boss' experience and interest. He has prejudices and pet viewpoints just like everyone else. If your project involves making a change of some sort, recite the old only in terms of the new, stressing the advantage of the new. Above all, make your report simple and brief. That is

what takes the hard work in preparation. Some of the visual aids, such as models and diagrams, described in the next chapter, may help. Eliminate unimportant facts and arguments or relegate them to an oral appendix, to be referred to at the end if necessary. Clarity and brevity are even more important here than in most oral reports. You are not only trying to keep the attention and interest of an audience—you are trying to keep the audience.

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8. DELIVERY: MECHANICAL TECHNIQUES —AUDIO AND VISUAL AIDS

Pictures and displays can convey ideas that would be impossible to tell in words. Graphs and diagrams convey ideas more clearly with fewer words. Audio aids transmit, augment and store the sound of words. However, the mechanical devices and techniques described in this chapter are merely *aids*. To be effective, they must be chosen and used with discretion. Think first of the ideas to be expressed. Then think of what methods and devices will help the audience understand the ideas.

AUDIO AIDS

Sound Transmitting

Most meeting rooms are equipped with the familiar public address system: microphone, amplifier and loud speakers. An attendant should be on hand to adjust the amplifier for volume and correct for "audio feedback howl" and other mishaps. Microphones to be worn around the neck and on the lapel are available; these permit the speaker to be heard when he moves away from the rostrum.

Figure 3 illustrates a wireless microphone. The transmitter and battery are carried in the speaker's pockets. The microphone is held in his hand or concealed behind his lapel. The receiver-amplifier unit picks up the mes-

sage and sends it to the loud speakers, or to a tape recorder. Thus, the speaker becomes an ambulatory broadcasting station. He can move about freely and discuss objects and equipment at a distance from the rostrum.



Figure 3. Wireless Microphone.

(Reproduced through the courtesy of Port-O-Vox Corp., New York).

He can mingle with the audience and answer individual questions for the benefit of the whole group. Also, an attendant can carry the device to members of the audience who want to ask questions or submit discussion. Workers and inspectors carrying the microphone can report from hard-to-get-at-places as they move about in mines, factories and construction projects. Similarly, security guards can report to headquarters as they patrol their

beats. The receiver and a tape recorder can be carried in an automobile and used to record observations and interviews in nearby stores and offices. The range of the transmitter is said to be one thousand feet indoors and up to one half mile outdoors.

Sound Recording

Just as pictures can be taken of objects that can't be brought to the meeting room, sounds can be recorded and played back for the audience. The sound can be a voice recorded to accompany a film strip sequence or a movie which is to be shown to different groups and in different places. The sound can be from a machine, a field operation, an animal or experiment, at normal volume or amplified.

A sound recorder permits a speaker to edit and polish his talk just as a writer does his manuscript for publication. The speaker need not be present when the final recording is played back for the audience. Of course, his presence may be required to answer questions and participate in discussion.

A speaker, especially an inexperienced one, can practice giving his talk in quiet, relaxing surroundings and record it. Stress and nervous tension won't plague him, for he knows that if he makes mistakes he can correct them. Then he can play back the recording, take advantage of criticisms and suggestions from his friends, erase all or part and try it again. While he speaks he is not worrying about the time limit. He knows he can eliminate and condense on the next try, if necessary.

A talk so recorded is suitable for occasions where re-

cital of facts or conclusions within a strict time limit is more important than the warm relation a speaker, in person, can establish with the audience. Such occasions are some presentations of technical papers at scientific meetings, and reports and recommendations to executives and committees in a business organization.

At the September 1950 meeting of the American Chemical Society in Chicago, Durban and Montgomery¹⁷ gave a highly successful demonstration of a tape-recorded presentation before the Division of Chemical Literature. They described and showed moving pictures of the preparation of a magnetic tape recording.

Sound Equipment

McMasters, Schwartz and Jenkins³³ describe, illustrate and analyze audio equipment and give 1954 prices. They also give an extensive bibliography.

The general classes are:

(1) Mechanical. Embossed—or engraved—groove recordings on discs, cylinders and flexible tapes and belts, as illustrated by the ordinary phonograph and most business dictating machines.

(2) Magnetic recordings, represented by magnetic-tape and -wire recorders, and magnetic belt dictating machines.

(3) Optical transmission (photographic film) recordings, as exemplified by the sound track of some motion picture films.

For the use described in the preceding section, a magnetic tape recorder is required. Any part of the record

can be changed by recording right over that part. The original sounds are erased and the new ones recorded. Magnetic tape also can be edited by cutting and splicing.

VISUAL AIDS

The type of graphic material to be displayed depends upon the intellectual content of the talk, and upon the audience. What ideas are to be expressed, and how can they best be clarified? The display equipment and method chosen will depend on physical factors: size of the audience and meeting room, lighting and black-out provisions, equipment available in the meeting room or in possession of the speaker or otherwise obtainable. The graphic material must be prepared so as to meet legibility and comprehension standards, and in a form suitable for the display or projection equipment to be used. Finally, the visual presentation must fit in smoothly with the oral presentation so that the two become one.

The visual material to be prepared and displayed may be one or more of the following:

- Graphs
- Charts
- Diagrams
- Maps
- Pictures
 - drawings
 - photographs
- Tabulations
- Samples
 - substances
 - merchandise

Demonstrations
processes
methods
Exhibits, Scale Models

Projection Equipment

The most commonly used visual aids are transparent slides, "Standard" $3\frac{1}{4}$ x 4 inch, and 2 x 2 inch. Projectors for the standard slides are routinely provided in meeting rooms of most technical societies. Some $3\frac{1}{4}$ x 4-inch projectors will also handle $2\frac{1}{4}$ x $2\frac{1}{4}$ -inch and 2 x 2-inch slides.

Wood and Melaven⁵³ describe and illustrate the modification of a slide projector for remote operation by the speaker.

Amateur-type 2 x 2-inch projectors having a lamp of 100-250 watt rating are suitable only for small rooms. Professional type 2 x 2-inch projectors having a lamp rating of 500 to 1,000 watts give a screen image at least equal in quality to most $3\frac{1}{4}$ x 4 inch projectors.

Special automatic features are available in various 2 x 2-inch projectors. The slides can be loaded into magazines and can be changed by remote control. A mechanism can be set to change slides automatically at a fast, medium or slow fixed cycle. A recorded commentary can be synchronized with the projector. In some machines, the slide changer is actuated by a high or low frequency signal in the record, in others by a period of silence. A special attachment permits projection of opaque objects such as stamps, coins, anything that will fit into the 2 x 2-inch space. Some projectors will handle film strips as well as slides. Some have a built-in pointer.

The overhead projector is illustrated in Figure 4. The light source in the base is directed upward through transparencies on the working stage and reflected to the screen by the overhead unit. The speaker faces the audience and manipulates the transparencies on the stage before him. The transparencies consist of a plastic film in a cardboard mount. The speaker may need no other notes than those he can make on the margin of the mount. His pencil or finger is shown on the screen as he

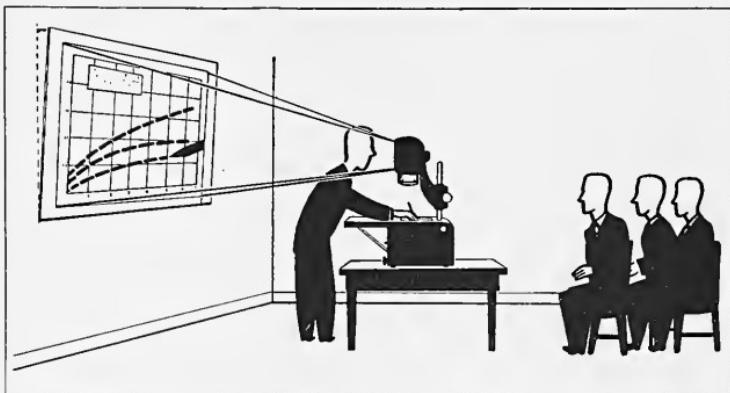


Figure 4. Overhead Projector in Use.¹¹

points to features on the transparency. He can build up a picture or diagram by using a series of transparent overlays. He can write on blank transparent plastic sheets and it appears on the screen as he writes. The blank plastic sheet is available in rolls, and can be transported across the stage as needed by knobs which actuate a set of rollers. One can show a chemical reaction in a flat, shallow glass dish. Opaque objects on the stage show on the screen in silhouette. In different models the size of the stage varies up to 10 x 10 inches. Some models

have attachments for projecting 3½ x 4-inch, and 35-mm slides and filmstrips and opaque objects.

Reflector-type or opaque projectors can be used to project an image of a flat, opaque object. Pictures, pages from magazines, rare documents, any flat, opaque material up to ten inches square and having adequate light reflectance can be shown. An advantage of this type of projector is that free or inexpensive material can be used for display. However, precautions are necessary. One should check the quality of the image on the screen to see if the light reflectance of the sample and darkening of the room are adequate. Also, it may be necessary to use a lower wattage bulb in the projector if heat sensitive material is to be shown. Furthermore the legibility of the image should be checked from the farthest viewing position.

Micro-projectors are available for showing microscope specimen slides. Some projectors will handle 70-mm X-ray slides and film strips, others 35-mm stereo slides which give three-dimensional effect. For viewing the latter, each spectator must have polarized glasses.

Automatic, continuous still projectors will show a series of slides, or 35-mm strip, over and over. Repetitive tape equipment can be used to synchronize sound with continuous projectors. Such equipment is used in connection with permanent displays and exhibitions.

Sixteen-mm motion-picture films are commonly used as industrial and educational visual aids. Thirty-five-mm film is used almost exclusively in commercial motion picture theaters. Eight-mm film is usually confined to home movies.

Four types of 16-mm sound films are available. The

first three have sprocket holes along one edge of the film and the sound track along the other: full track optical sound, full track magnetic sound and half-track magnetic sound alongside the optical sound. The optical sound cannot be changed. The magnetic sound can be erased and re-recorded as often as desired by playing it through a suitably equipped sound projector which is really a combination projector and tape recorder, the film being the tape. The fourth type of 16-mm sound film is silent film which has been converted to sound by adding a quarter track magnetic strip along one edge outside the row of sprocket holes.

Cameras are available for slow motion and time lapse photography. The projected film makes motion perceptible which is too fast or too slow for the human eye. Some movie cameras can speed up or slow down motion by a factor of four. Some will operate at the various speeds which conform to the standard decimal system used in time-motion studies. Special equipment is available for study and research which can take thousands of exposures per second. When such film is projected at the normal rate, high speed action is slowed and can be studied and demonstrated.

The use and production of movies for technical and scientific purposes are discussed in references 4, 9, 20, 26, 44, 51.

Easel Displays

The familiar blackboard of our school days is convenient for informal presentations, and for drawing unanticipated diagrams and formulas called for during

question and discussion periods. Chalkboards in pastel shades such as light green, blue or tan, and dustless marking crayons are suitable for some uses but have less contrast than blackboards, and can't be used with a full range of colored chalk. Chalkboards and blackboards are mounted permanently in the walls of classrooms and meeting rooms. They are also available on portable easel mounts.

A blank paper pad mounted on an easel serves the same purpose as a chalkboard. It has the added advantage that when a sheet is filled it may be flipped over the back or torn off, and the notes, such as suggestions made during a conference, are saved. Some pads are about 2 x 3 feet, some are 45 inches wide. Sheets can be had with vertical and horizontal rulings, light blue lines one inch apart for making graphs. This inconspicuous ruling also serves as guide lines for lettering. Sheets with the same ruling in black can be used under plain sheets as a guide.

Charts can be prepared in advance and each one flipped over the back of the easel after it has been shown. Pads of transparent sheets can be used for preparing overlays.

"Slapboards" are used similarly with material prepared in advance. Pictures, words, slogans, symbols are mounted on suitable material, cut into appropriate shapes and slapped onto the board one by one to build up an idea. Magnetic boards are backed with an iron sheet and the display material is held to the board by small magnets. Flannel boards consist of a sheet of flannel mounted rigidly or on a window shade roller at the top of the easel. The display material is mounted on

paper or cloth backed by fibrous floc which clings to the flannel.

Easels for supporting the pads and boards are available in various sizes and styles: floor, table and wall. Some are adjustable for height and width. Some permit raising and lowering the pad so one can write always at the same level. Some have accessories such as a light, and side arms for supporting additional charts. One model consists of two easels joined back to back and mounted on casters. One side can hold a blank paper pad, and the other a chalk- or slapboard, or a series of prepared cardboard charts.

Auxiliary Equipment

A lectern or reading desk is usually provided in meeting rooms. Floor and table models are available. The light should be on a separate circuit. It should be shielded so that it doesn't shine on the projection screen or audience.

A "portable pulpit," to be held in the speaker's hand, is on the market. It is a clipboard for holding manuscript or notes and is equipped with a shielded light and device for signalling the projectionist.

The "TelePrompter" is illustrated in Figure 5. The script is typed in large letters on a strip of paper which is then mounted on rollers. The strip is moved through the viewing position in pace with the speaker's delivery. The movement can be controlled by an attendant or by the speaker.

The electric pointer looks like a large flashlight and projects an image of an arrow onto the screen. It is pref-

erable to wood and bamboo pointers if the screen is large and if the speaker would otherwise need to move away from the microphone to point.



Figure 5. "TelePrompTer"

(Reproduced through the courtesy of The TelePrompTer Corp., New York).

Projection equipment is illustrated and described by Bonnell, Paul and Rice.¹¹ Various types of mechanical aids are illustrated and discussed briefly by Connelly¹⁴ and in reference 51.

Sources of Equipment

Information about equipment and operating techniques can be had from manufacturers and from retail stores that handle such equipment. See references 7, 38, published by The National Audio-Visual Association, Inc., Fairfax, Virginia.

STANDARDS AND SPECIFICATIONS FOR VISUAL AIDS

Standards for Legibility ^{20a, 23, 31, 32, 46}

Standards for legibility of display material fall into two main, inter-related categories:

- Viewing conditions
- Design of the material

For material viewed by reflected light, the illumination on the surface to be viewed should be equal to or greater than that falling on other surfaces within the field of view. The illumination should be between 25 and 50 foot-candles and should be directed so that there is no surface glare.

For material viewed by projection, the ratio A/W, between screen image width, W, and distance from the screen to the viewer, A, should be not more than 6 for the farthest viewer and not less than 2 for the nearest viewer. Under special conditions, a larger ratio for the farthest viewer can be tolerated.

W is about nine-tenths times the full screen width. Figure 6 shows a plan view of recommended projection facilities. The projector with a blank slide should produce a screen image brightness of at least 9 foot-lam-

berts, 20 foot-lamberts is preferred. The screen image brightness should be at least twice as great as any other bright area in the field of view. The ratio of the non-image brightness of the screen (projector turned on but the lens capped) to the brightness when illuminated by

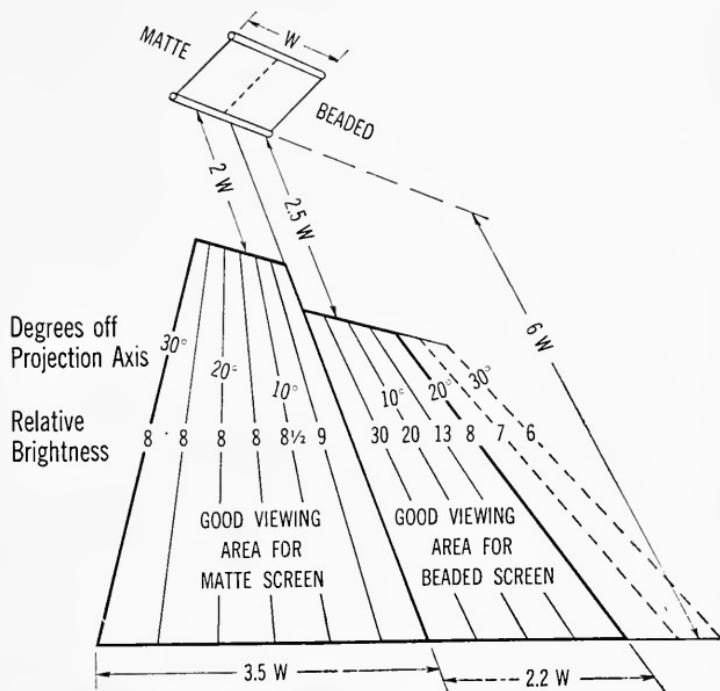


Figure 6. Recommended Projection Facilities.^{20a}
(Reproduced through the Courtesy of the Eastman Kodak Co.)

the projector with a blank slide should be suitable for the type material being shown. For full scale black and white and color where pictorial values are important and color differences must be discriminated, the ratio Non-image brightness/Projector image brightness, should be no more than 1/100. 1/300 is preferred. For

color diagrams and continuous tone black and white in high key, the ratio may be 1/25. For simple line materials such as text and graphs, the ratio may be 1/5.

One of the criteria for design of display material is illustrated in Figure 7. The minimum subtended angle of vision, x , should be 9 minutes of arc. The tangent of 9 minutes is about 1/384, so the minimum symbol height should be that fraction of the distance from the display or screen image to the farthest viewer. This is equivalent to one inch for a maximum viewing distance of 32 feet.

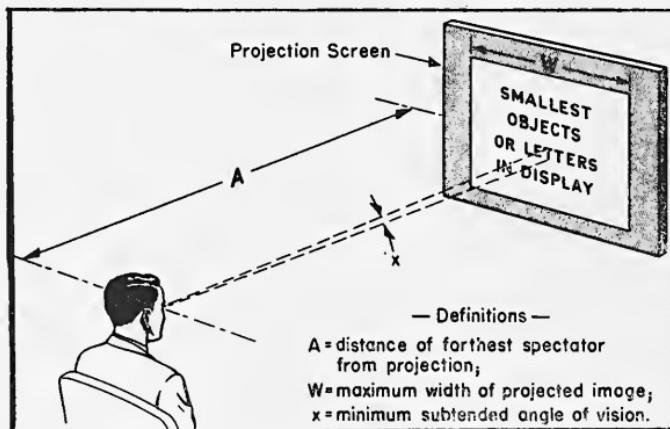


Figure 7. Minimum Angle of Vision.¹¹

(Courtesy F. R. Gruger, Jr.)

When the size of letters and figures is near the minimum, a sans-serif, medium weight face of normal proportions should be used. Capitals are recommended for titles, labels and other short statements. For two or more lines of text, lower case should be used, and the lines should be spaced one and one-half to one and two-thirds times the height of the letters.

The ratio, Letter height/Pen line width, should lie between 6.75 and 7.5 for alphabets in which the "0" is 0.8 as wide as high (See Table 2).

TABLE 2. MECHANICAL LETTERING SETS

LEROY					
Template No.	Pen No. (a)	Pen line Width In.	Max. Letter Height In.	Ratio: Letter Height to Pen line (b)	
80-C	00	0.013	0.08	6.2	
100-C	00	0.013	0.10	7.7	
120-C	0	0.017	0.12	7.1	
140-C	1	0.021	0.14	6.7	
175-C	2	0.026	0.175	6.7	
200-C	2	0.026	0.190	7.3	
240-C	3	0.035	0.240	6.9	
290-C	4	0.043	0.290	6.7	
350-C	4	0.043	0.350	8.1	
425-C	5	0.055	0.425	7.7	
500-C	6	0.067	0.500	7.5	
WRICO					
Template No.	Pen No. (a)	Pen line Width In.	Max. Letter Height In.	Ratio: Letter Height to Pen line (b)	
90 VCN	7	0.018	0.09	5.0	
120 VCN	7	0.018	0.12	6.7	
140 VCN	6	0.025	0.14	5.6	
175 VCN	6	0.025	0.175	7.0	
200 VCN	6	0.025	0.20	8.0	
240 VC	4	0.036	0.24	6.7	
290 VC	4	0.036	0.29	8.1	
350 VC	3	0.048	0.35	7.3	
425 VC	2	0.060	0.425	7.1	
500 VC	2	0.060	0.500	8.3	

Space between the letters should be at least twice the line width and between words at least twice the letter height.

The width of the lines in sketches, diagrams and graphs should be gauged according to relative importance. Grid lines and minor rulings should be about one-half the width of the type line. Major rulings, such as axes and outlines of vessels and structures, should equal the type line width. Curves and flow lines should be one and one-half to two times type line width.

The art work for copy to be reproduced on a slide should be proportioned to match the mask opening of the slide. For standard slides the ratio, height-width, is about 3/4.

The final art work should be tested by viewing it from a distance equivalent to the position of the farthest viewer. If the copy is to be reproduced on a slide or in a publication, it should be viewed from the distance, D, at which it will subtend the same angle as will the projected or reproduced image.

$$D = C \cdot \frac{A}{W} \quad (1)$$

D = Test viewing distance (in same units as C)

C = Width of copy (original art work or finished slide)

A = Distance from screen to farthest viewer in feet
(or same units as W)

W = Screen image width, in feet (or same units as A)

Example:

A standard slide is to be shown in a meeting room where $A/W = 6$. The copy width on the slide is almost three inches. Therefore, $D = 18$ inches.

Using some of the above specifications, the following equation is derived from the geometry of projected screen image from copy:

$$h = 0.0026 \frac{A}{W} \cdot C \quad (2)$$

h = Minimum letter height on copy, in inches (or same units as C)

C = Copy width, in inches (or same units as h)

A = Distance from screen to farthest viewer, in feet (or same units as W)

W = Screen image width, in feet (or same units as A)

From this equation, one can design copy for any A/W ratio. The copy can be reproduced on a slide of any size. Then the image will meet specifications when projected to the screen image width, W . The recommended maximum for A/W is 6. However, if the A/W ratio of the meeting room is not known, it is safer to design copy for $A/W = 9$.

Lettering done with mechanical lettering sets is preferable to free-hand lettering. Table 2 shows the size pen to be used with whatever template gives the letter height, h , calculated from Equation 2.

Example: Assume copy width of 10 inches.

For standard slides the height will be 7.5 inches ($\frac{3}{4} \times 10$ inches). Assume $A/W = 9$. Then, from Equation 2, $h = 0.234$ inch.

Refer to Table 1. Use Leroy template #240-C and pen #3, or Wrico template 240-VC and pen #4.

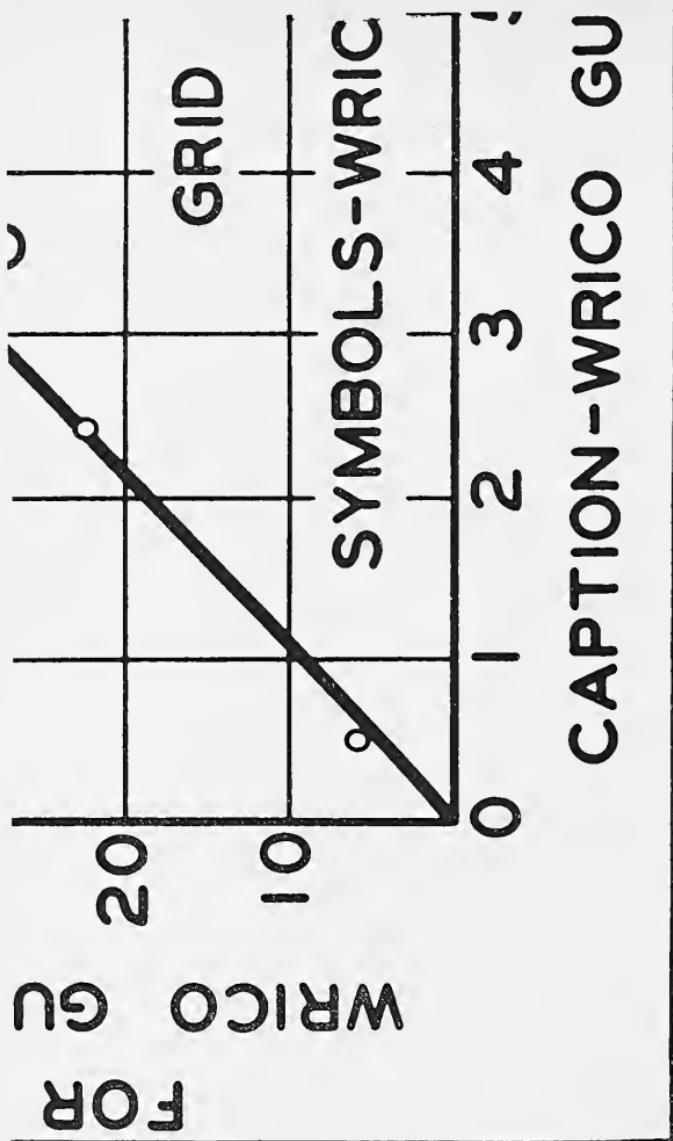


Figure 8. Portion of Original Slide Copy, Full Size.

(From Cross, et al.¹⁶ Reproduced through the courtesy of the Division of Water, Sewage and Sanitation Chemistry of the American Chemical Society.)

Figure 8 shows a portion of original copy prepared as above, full size. Figure 9 shows the finished slide, full size.

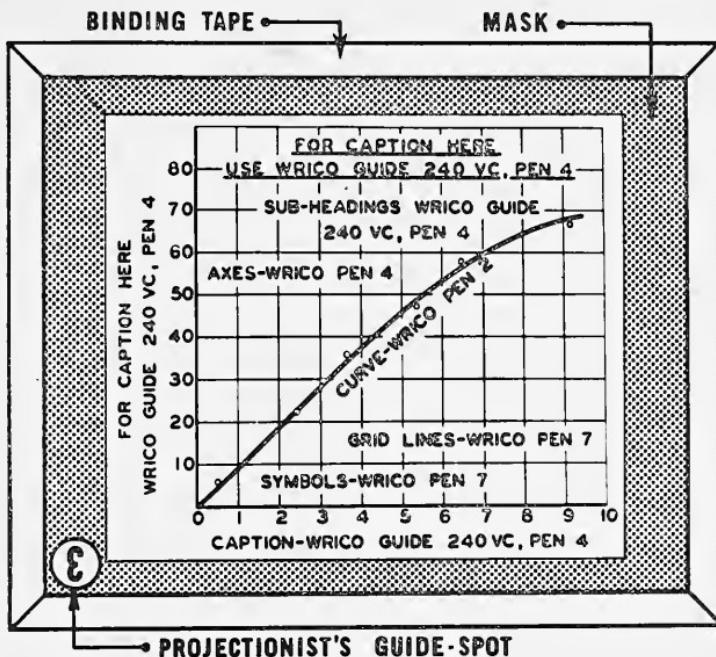


Figure 9. Finished Slide, Full Size, Made from Copy Shown in Figure 8.

(Courtesy Cross, et al.¹⁶ & Division of Water, Sewage and Chemistry of the American Chemical Society.)

Existing slides can be evaluated by calculating the A/W ratio, and the maximum viewing distance for a given screen. Substitute the letter height, h, and width of copy, C, on the slide into Equations:

$$\frac{A}{W} = \frac{384 h}{C} \quad (2a)$$

$$A = \frac{384 h W}{C} \quad (2b)$$

Conventional thin-line typewriting (Pica or Elite) with a fabric ribbon is not recommended for preparing slide copy. Such typing is satisfactory if carbon paper is used on front and back of lightweight coated paper. Electrically actuated machines having boldface type, preferably Gothic (sans serif) at least 0.1 inch high, and equipped to handle carbon paper ribbon are suitable. Especially recommended are those machines with proportional letter spacing.²³ Maximum width for such typed copy can be calculated from another rearrangement of Equation 2:

$$C = \frac{384 h}{A/W} \quad (2c)$$

Example: Assume the letter height is 0.1 inch and $A/W = 6$. The maximum copy width should be about 6% inches.

Standards for Comprehension ^{10, 23, 27, 28, 34, 50}

Slides should be brief, clear and simple. There should be fewer data on a slide than would be permissible in a similar graph, diagram or table for publication or permanent display where the reader can take his own time to study it. Various recommendations for maximum viewing time for a slide range from one to two or three minutes. The usual minimum is about one-half minute. Although it is desirable that a slide be self-explanatory, overcrowding with captions should be avoided. The speaker can give some of the explanation of necessary. The graphical part should be comprehensible almost at a glance.

Each slide should represent only one central idea displayed in a concise, simple form. Avoid unnecessary captions, equations and extraneous details. Put on the slide only what will be mentioned in the presentation.

Two or three simple slides are more effective than a single complicated one. A rule of thumb has been suggested: "Don't put on a slide more than you can write on the blackboard while you are discussing the slide."

The usual general recommendations for maximum slide copy are, for black and white:

Not more than three or four dissimilar curves on one graph.

Avoid closely interlaced curves.

Titles short, captions few.

Use tables only if the information cannot be presented graphically.

Not more than twenty data in a table, including captions.

No more than 350 letters and figures or 50 words of seven letters each on a word chart.

For chemical formulas and mathematical equations, the recommendations range from two or three lines to ten. Each of those limits seems extreme. The maximum might well be not much more than a hundred individual letters, figures and symbols.

For diagrams, try to estimate the graphical equivalent of the above recommendations.

The use of color will help differentiate between curves, areas on maps, and various parts of charts and diagrams.

A word chart, representing an outline of what is to

follow, or a summary of results or conclusions, should be a short list of key words or phrases. The speaker then briefly explains each word or phrase in turn. It is usually undesirable to write full sentences on such a word chart.

The nomenclature, both verbal and graphical, should be comprehensible to the audience. In a formal report to a scientific society meeting use standard nomenclature, graphical symbols and abbreviations. Consult your national technical society and the American Standards Association. Also see the nomenclature references at the end of this chapter.

Standards for Design of Copy

Graphs and Charts.^{6, 13, 23, 34, 45, 54} The type of graph should be chosen which best illustrates the relationships among the data to be presented. Continuous relationship between two variables is best illustrated by the familiar continuous curve. Histograms are bar graphs with no space between the columns, and are used for a variable which can be varied continuously, when only a limited number of data are available. Periodic and static data should be represented by a bar graph. For such data a continuous curve may give an erroneous idea of continuity of relationship that does not exist. Bar graphs can be used to show more than one set of values. Each series can be identified by its particular cross-hatching or color. When the data represent the relative parts of a whole, static data should be shown in the form of a "pie" chart.

The coordinates on graphs may be rectangular, trilin-

ear, polar, the scales arithmetical, logarithmic or other. The coordinates, scales and function of the variable, should be so chosen that the slope, shape and relative position of each curve clearly show the idea that is to be illustrated.

The scale graduations should be numbered in units of 1, 2 or 5, multiplied by powers of ten. If the power of ten is shown, as such, it must be clear whether the unit *is to be* or *has been* multiplied by the power of ten.

The scale title for the dependent variable is usually placed vertically along the left ordinate axis. Some authorities recommend that it be horizontal and at the left or top. The title for the independent variable should be placed horizontally under the abscissa axis. Occasionally a title at the top of the slide will eliminate the need for an ordinate scale title. The scale titles and also parameter values for families of curves should indicate the variable and its units.

The number of grid lines usually should be restricted to about five horizontal and six vertical lines. The viewer can make only approximate estimations of values on the curve in any case. Too many grid lines merely clutter up the slide and distract attention from the curves. Some graphs will be neater and clearer if short stubs along the axes are substituted for grid lines. The grid lines should be broken where they cross captions and data symbols and where they cross curves if the curves are to be colored.

The clearance between curves should be not less than the minimum letter height. Each curve should be identified by a short, horizontal word caption next to the

curve. Avoid using a number key. It may be clearer to vary the type of line to distinguish between different sets of matched pairs in a group of curves than merely to use different data symbols. If the lines are varied, use in the order, solid line, long dashes, short dashes, dots, alternating dots and dashes.

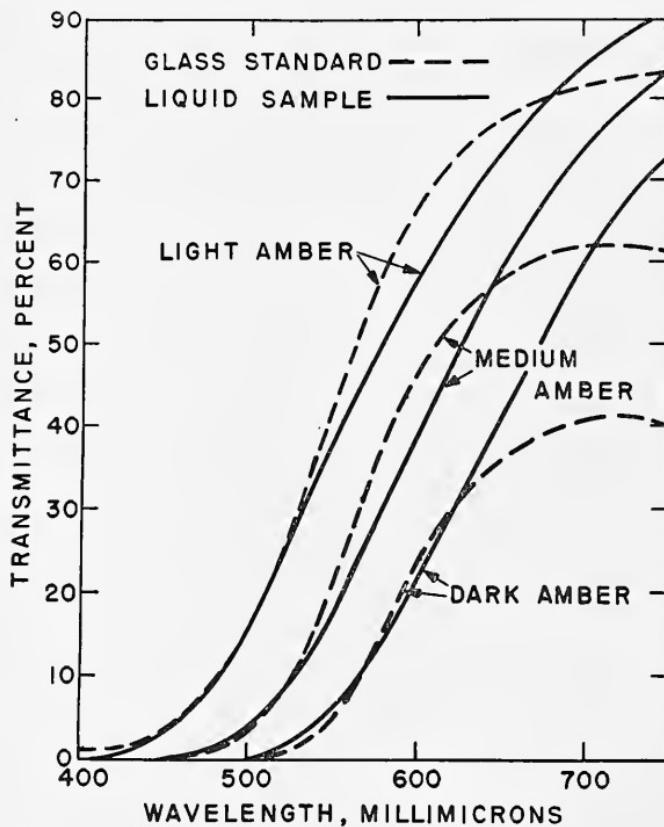


Figure 10. Michener's³⁴ Recommended Maximum Copy for a Slide.
(Slightly Revised).

(Reproduced through the courtesy of the Journal of
Chemical Education.)

Michener³⁴ gives some excellent illustrations of good and bad copy for slides. Figure 10 shows his recommended maximum number of related curves that should be put on one slide. Figure 11 shows his example of overcrowding. Figure 12 shows a dimetric diagram illustrating the interrelation of three-dimension data.

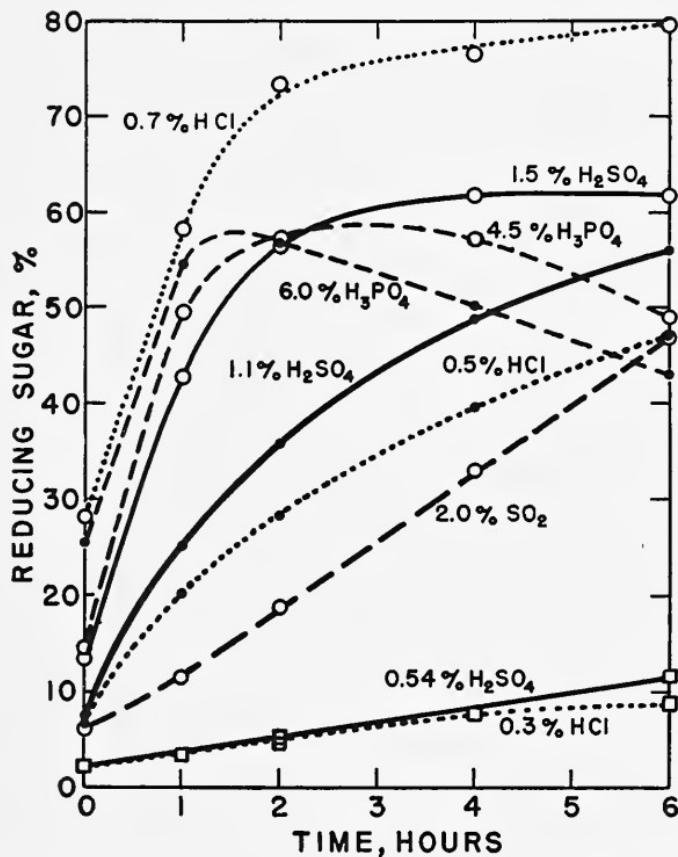


Figure 11. Michener's³⁴ Example of an Overcrowded Slide.
(Reproduced through the courtesy of the Journal of Chemical Education.)

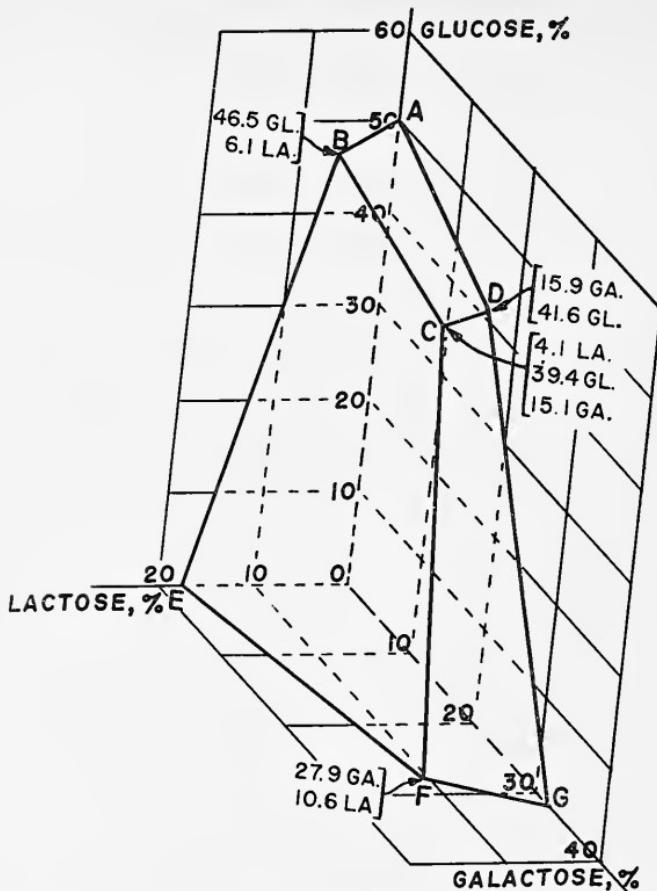


Figure 12. Dimetric Illustration of Three-dimension Data. Michener.³⁴
(Reproduced through the courtesy of the Journal of Chemical Education.)

Avoid unnecessary data symbols. They should be used only when it is *necessary* to show the distribution of experimental or observed points. Even then, too many symbols are confusing. Include no more than the viewer can comprehend in the limited time the slide will be shown. Recommended symbols are circle, square, tri-

angle and diamond. Open symbols should have about the same line weight and height as the smallest capital letters used. The height of solid symbols should be two-thirds of the letter height.

Bar graphs should be used in place of tables for slides whenever possible. The data should be classified and grouped as described for tables in the next section. The bars should be separated by a space of one-fourth to one-half of the bar width. The bars may be differentiated by cross-hatching or shading, solid white, solid black and color. The lines in the hatching should not be parallel to the ends or sides of the bars. The bars are usually vertical in keeping with the conventional independent variable as abscissa and dependent variable as ordinate. However, it may be convenient to place the bars horizontally if each is to have a word label, so that the words can be listed horizontally along the left axis for easy reading.

Pictorial charts and diagrams³⁶ are useful for exhibits and displays before a non-technical audience. On pictograph charts the symbols should be self-explanatory, simple, conventionalized representations so the meaning or comparison can be grasped at a glance without even reading the captions. Quantities should be indicated by the number of symbols, not by the size of the symbols. Only approximate comparisons can be indicated. Economic and social statistics are often presented on pictograph charts. An example of an application for a pictorial diagram would be illustration of the hydrologic cycle: precipitation, run off, infiltration, transpiration, evaporation.

Tables.^{2, 3, 15, 30, 54} A table is an orderly arrangement of items of information to facilitate finding or comparing the items. Suitable for tabular arrangement are data too few or too diverse for graphing or too indefinite for assignment of numerical values. Especially suitable are data which may be classified and sub-classified in different ways.

Figure 13 shows the usual form and terminology for tables.

**THE MAIN HEADING MUST BE ADEQUATELY DESCRIPTIVE
BUT SHOULD NOT REPEAT BOX AND STUB HEADINGS**
(The headnote * comments on all contents of the table).

	<i>These are the</i>	<i>Box headings †</i>
These Are the Stub Headings †		

* Headnotes are centered and footnotes are indented.

† Capitalize only the first word in box and stub headings.

Figure 13. Form and Terminology for Tables
(Anderson.³ Reproduced through the courtesy of *The American Association of Cereal Chemists*).

If four or more data are presented, they should be shown in tabular form. Also, qualitative and descriptive comparisons and contrasts are more easily understood in tabular form than in verbal exposition. Note in Figure 14 that the information in the tables can be grasped more quickly than the preceding exposition. The differ-

EXAMPLE 1

The daily low-X diet, called Diet A, was prepared by adding to 10 g of skim milk the equivalents of 0.0003g of iron from $\text{FeSO}_4 \cdot \text{H}_2\text{O}$, 0.0001 g of zinc from $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2$, 0.0001 g of copper from $\text{CuSO}_4 \cdot 5 \text{ H}_2\text{O}$, 0.0026 mg of iodine from KI, and 0.0008 g of manganese from $\text{MnSO}_4 \cdot \text{H}_2\text{O}$.

Table 1

MINERALS OF LOW-X CONTROL DIET, DIET A

Mineral	mg/10 g Skim Milk	Source
Fe	0.3	$\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O}$
Zn	.1	$\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2$
Cu	.1	$\text{CuSO}_4 \cdot 5 \text{ H}_2\text{O}$
I	.0026	KI
Mn	0.8	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$

EXAMPLE 2

Streaked animals, ss, can be produced only by the following matings:

(a) streaked ss x streaked, (b) heterozygous Ss x streaked ss, (c) heterozygous Ss x heterozygous Ss. In mating (a) all offspring will be streaked; in mating (b) in which one of the parents was streaked ss and the other was heterozygous Ss, half of the offspring will be streaked; in mating (c) in which both parents are heterozygous, one-fourth of the offspring will be streaked.

Table 2

MATINGS REQUIRED TO PRODUCE STREAKED ANIMALS, ss

Parents	Offspring ss
Streaked ss x Streaked ss	All
Heterozygous Ss x Streaked ss	1/2
Heterozygous Ss x Heterozygous Ss	1/4

Figure 14. Advantage of Tables Over Exposition.
(*Cortelyou*.¹⁵ Reproduced through the courtesy of the Journal of Chemical Education).

ence is even more striking when the exposition is given orally.

Tables for publication and permanent display should have a number and a brief but informative title. Sometimes it is desirable to omit the title on slides. Columns and rows should have identifying headings, and should be used to group related data. Units of measurement should be given and all units should be of the same system. The same unit should be used for comparable properties and dimensions.

If an item is repeated several times in a table, perhaps the table can be rearranged and simplified by listing the item only once, in the title, in a footnote or in a stub or box head. In a table reporting a series of experiments with some factors constant for certain groups and other factors varying, the data usually should be grouped according to the constant factors.

The chronological order in which the data were obtained usually is not significant. The sequence of items in a table should relate to a factor which brings out the significance and relationships of the data. Similarly, items of record interest only, such as laboratory test numbers, initials of analysts and clock times should be omitted in a table. If the results obtained by different analysts or different laboratories is significant, the results should be grouped accordingly. Such results should be listed not according to laboratory number or in chronological order, but in ascending or descending order of magnitude. If time is significant, the results should be grouped according to the significant factors such as the lengths of the various time intervals. The re-

sults of observing or analyzing a continuous process at intervals might better be plotted graphically with time as the abscissa.

Similar tables, such as physical constants of various groups of chemicals, should all be set up in the same manner with the constants always in the stub or always as box column heads. No more than two or three significant figures for each numerical item should be given in a table to be used on a slide.

A column of numerical items, each having the same unit, should be aligned at the decimal point. Numerical items having different units should be centered in the column, not aligned, and the units and necessary description given in the stub.

Numerical values can be compared more readily when listed vertically rather than horizontally. An explanatory phrase should be listed in the stub in preference to listing as a box head.

Diagrams and Maps.^{3, 23, 34} The previously discussed general principles for legibility and comprehension, of course, apply also to diagrams. The proper application of the principles is up to the author's ingenuity and judgment. The almost infinite variety of diagrams that may be conceived make it impossible to compose recommendations as specifically as can be done for height of letters and width of lines. However, the fundamental principle is the same as for all visual aids: the details must be clearly discernible, suited to the viewers knowledge and experience, and comprehensible under the time and space conditions of display.

Working or shop drawings are not suitable for slides. Non-essential details should be eliminated. The cap-

tions and equipment and structures illustrated must be simple. Only those which illustrate the central idea and which will be referred to in the talk should be included. For flow diagrams, conventional symbols or simplified schematic yet easily recognized shapes and outlines should be used rather than an exact likeness of the machinery and equipment.

Figure 15 illustrates a good flow diagram of a process.

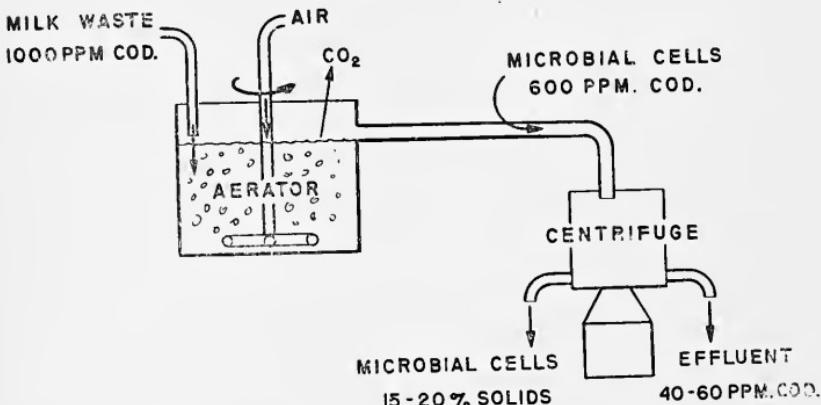


Figure 15. Illustration of a Good Flow Diagram. Michener.³⁴
(Reproduced through the courtesy of the Journal of Chemical Education.)

For illustrating structure or function of a machine or piece of equipment, cut-away diagrams are often used. An exploded view is effective for showing the relation of parts in an assembly. Especially effective are dimetric, isometric and perspective projections.

Maps for display should be specially prepared. As with other diagrams, extraneous details in maps will confuse the viewer and obscure the central idea. The boundaries and places to be illustrated should be bold and

clearly labeled. Areas should be differentiated by cross-hatching or color. The scale should be shown.

If the map includes so large an area that distortion due to the earth's curvature is significant, the projection used should be indicated unless the map is of a type with which the viewers are familiar.

Pictures.^{3, 5, 26a, 30, 43, 47} Photographs show every detail impartially. The emphasis on each detail is related only to its size, position, number of other details, and color or brightness contrast with its surroundings. Those factors may be advantageous or disadvantageous for a given application.

Photographs should be used when the purpose is to give an overall view or to show exact appearance, texture and color. Examples are landscapes, geological formations, biological specimens, pathological conditions, progressive results of weathering or other tests, mechanical failure, manufactured products and microscopic and telescopic views.

A line drawing or a series of drawings should be used when the purpose is to illustrate the essential details of a complicated assembly. In a photograph, the maze of bolts, nuts, supports, pipes, and wires would obscure small but essential details. When the purpose is to illustrate function or relationship of parts, a diagram may be more effective than a realistic drawing or a photograph.

The proper composition, background and lighting of the object to be photographed require not only knowledge of the subject to be illustrated but also ingenuity and imagination. It is only the author who knows what idea he wants to express and it is he who must decide what is to be photographed and how it should be ar-

ranged and viewed. That is an art that can't be described precisely. However, some general recommendations and suggestions will be given.

There should be some indication of scale in the picture. The scene should include some familiar object, such as a person standing at the foot of a sheer cliff, and a six-inch rule or a geological hammer in a close-up view of a rock formation, and a scale mark on photomicrographs, as shown in Figure 16.

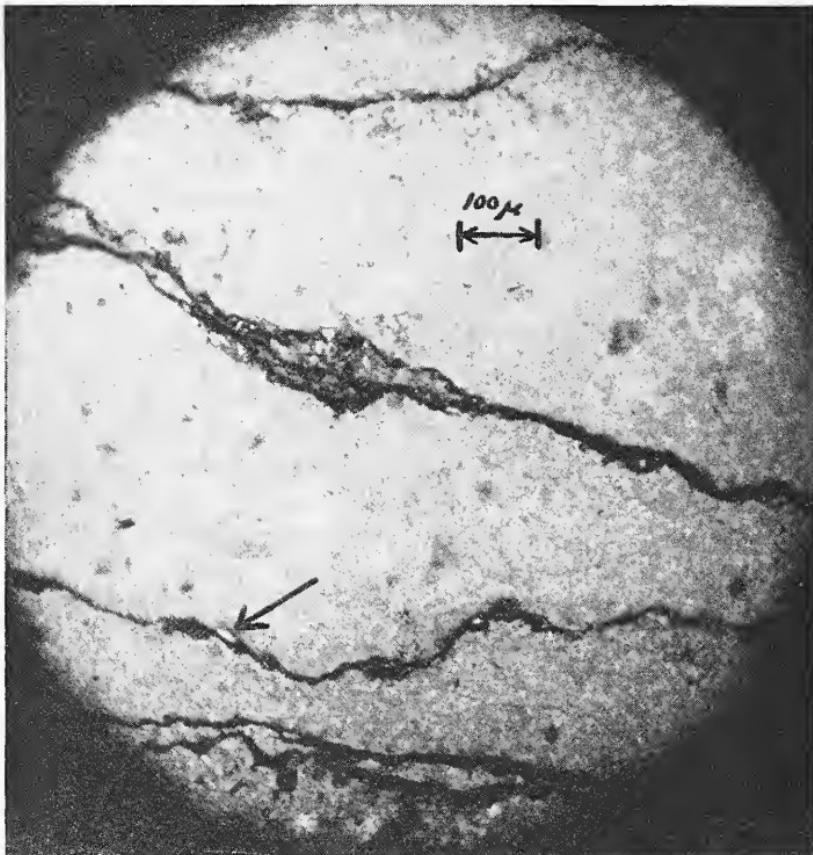


Figure 16. Illustration of a Photomicrograph. Slate.⁴³

The features of interest may be indicated with an arrow or outline. This should be done on slides, so the speaker need not turn away from the audience to point.

Labels can be lettered on an overlay with the negative or on the positive or on cards placed in the scene to be photographed. The minimum size for the lettering can be calculated from Equation 2, page 115, by substituting for C the width of the print or the width of the scene to be photographed, as the case may be.

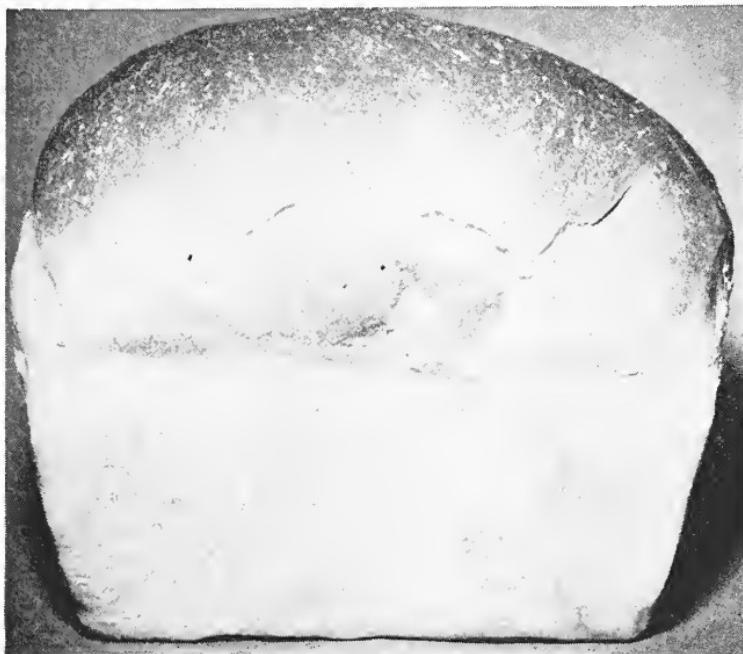


Figure 17a. Angle of Illumination, 90° with the Surface of the Loaf.

The illumination of the subject should be arranged so as to emphasize the features to be illustrated and to avoid distracting shadows. If a series of objects is to be photographed, each object should be illuminated from

the same direction so that concavities and convexities will not be confused with one another. The principle illumination should come from the left and above. A recommended arrangement for general use is the stronger light (twice the brightness of the weaker light) 45° to the left of the camera and 45° above it, the weaker light level with the camera and less than 45° to the right. To show surface texture, the direction of the illumination should make a small angle with the surface to be photo-

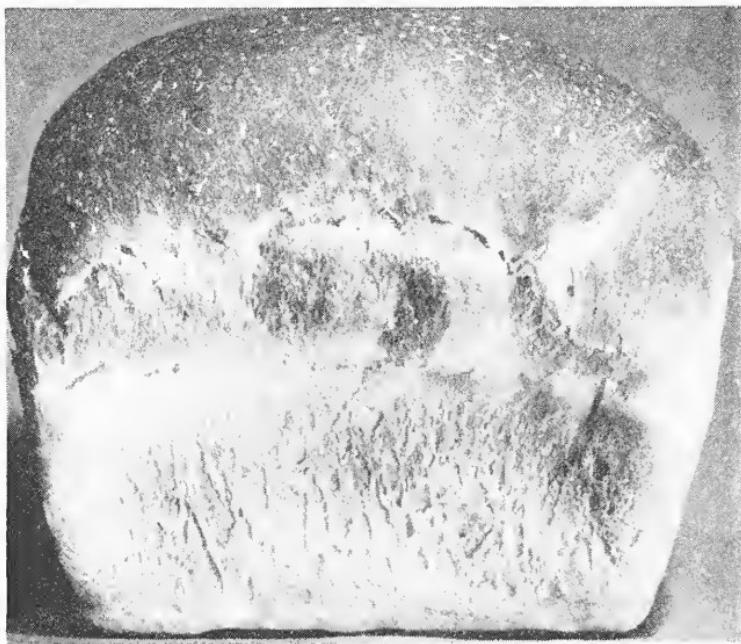


Figure 17b. Angle of Illumination, 30° with the Surface of the Loaf.
(Courtesy J. A. Anderson, Winnipeg, Manitoba.)

graphed. Figure 17a shows a loaf of bread illuminated from the front. In Figure 17b the illumination makes an angle of 30° with the surface of the loaf.

The background should be arranged to eliminate unwanted and distracting details and should contrast with

the object to be photographed. A table or shelf against a blank wall will serve. Paper, cardboard or cloth can be placed behind a piece of apparatus or machinery that cannot be moved. For a very dark subject, a light gray background is better than white. Similarly, a dark gray background is better than black for a very light subject.

Symmetrical rectangles for display material can be designed by using the following length to width ratios²⁴:

2.236 : 1	1.732 : 1	1.000 : 1
2.000 : 1	1.414 : 1	

CONSTRUCTION OF VISUAL AIDS

After the graphs, diagrams and pictures have been designed, the sketches are drafted into final form for display or for photographing and printing on glass or film for slides. Charts and diagrams being prepared for publication can be photographed at various stages for the preparation of a series of slides or transparent overlays for overhead projection. Diagrams can be photographed before hatching or shading and the prints colored for slides.

Description of the physical and chemical techniques of taking pictures and making prints is beyond the scope of this section. The author can get such information from camera manufacturers and dealers and from references 1, 49 or he can engage a professional photographer or experienced amateur.

Copy preparation. For the author who wants to make his own final draft, many mechanical drafting aids are available from stationers and dealers in art supplies. See section "Local A-V Production" in reference 7.

The most widely used lettering guides are "Wrico" * and "Leroy." †

Templates and stencils can be obtained for drawing conventional outlines and symbols for chemistry, various fields of engineering, plant and store layout, household furnishings, traffic symbols and plumbing.

Letters, numbers and symbols printed on white opaque or transparent stock are made up into pads. ‡ The characters are removed from the pads, assembled in a composing stick and attached to the copy with pressure sensitive transparent adhesive tape. Also, characters are printed on transparent film backed with pressure sensitive adhesive for mounting on copy. §

A wide assortment of type faces and symbols is available, including musical, electrical and pictorial symbols, trade marks and other special symbols, conventional cross-section symbols, cross-hatching, shading and colored transparent films. The film is attached to the copy, the desired outline cut with a sharp knife or needle-point, and the surplus film removed.

In photographic composing machines ¶, the desired

* Wood Regan Instrument Co., Nutley, N. J.

† Keuffel & Esser, 300 Adams St., Hoboken, N. J.

‡ "Fototype," Inc., 1414 Roscoe Street, Chicago, Ill.

"Prestotype." Arthur Brown and Bros., Inc., 2 West 46th St., New York 36, N. Y.

§ Artype, Inc., Barrington, Ill.

"Contak." Transograph Co., 31 West 15th St., New York 11, N. Y.

"Craftype." Craftint Mfg. Co., 1615 Colamer Ave., Cleveland 10, Ohio.

"Zip-a-Tone." Para-Tone, Inc., 510-12 West Burlington Ave., LaGrange, Ill.

¶ "Typro." Halber Corp., 4151 Montrose Ave., Chicago 41, Ill.

Filmtype Corp., 7500 McCormick Blvd., Skokie, Ill.

"Headliner." Vari-Typer Corp., 720 Frelinghuysen Ave., Newark 12, N. J.

characters are contact printed photographically on opaque or transparent strips. A negative strip bears all the characters for that particular font. Each character in turn is aligned by a knob, and exposed by pressing a button. The exposed positive strip is developed in the machine and is then ready for mounting on the copy.

The "VariTyper"^{*} is a special proportional spacing typewriter, which can be equipped with many different type fonts. It can be used to prepare copy with justified right-hand margins.

Figure 18 illustrates the use of "Justi-Type" † a specially prepared paper mounted on a stretchable base. One can type with an ordinary typewriter and justify the right margin.

Graphs can be drawn on cross-section paper having light blue or light green rulings, and the rulings will not show when photographed.

Mixon³⁵ reports if there are fifteen or more graphs with similar scales, symbols and captions to be prepared, such scales and legends should be drawn on tracing paper and reproduced by photo-offset, or they can be reproduced on "Eze-Stik," ‡ pressure sensitive adhesive backed paper. The scales and legends can then be cut apart and attached to the graphs with a saving in drafting time.

Simplified sketches and perspective views can be made by tracing on a translucent sheet laid over a photo-

* Vari-Typer Corp., 720 Frelinghuysen Ave., Newark 12, N. J.

† Foto-Type, Inc., 1414 Roscoe St., Chicago 13, Ill.

‡ Simon Adhesive Products, 35-02 48th Ave., Long Island City 1, N. Y.

graph. Cut-away views can be made in this way by tracing successively from different photographs.

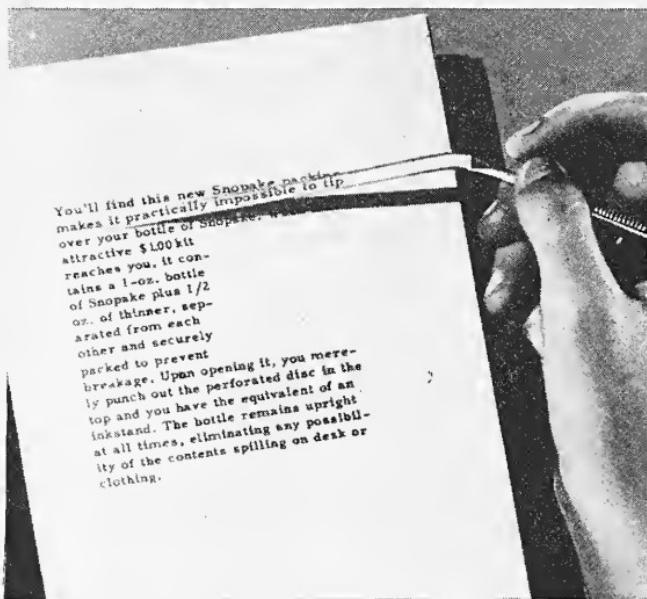


Figure 18. Use of "Justi-Type".
(Courtesy of Foto-Type, Inc., Chicago.)

Pads of translucent sheets are available which can be placed over guides ruled for isometric and other types of sketches.

Making Slides

The copy is photographed and printed on a glass plate. A mask is placed on the emulsion side of the plate and a cover glass placed over the mask. The two glasses are taped together with adhesive-backed cloth tape around

the edges. Permanently tacky adhesive, such as pressure sensitive cellophane tape should not be used. Such adhesives break down in the heat and light from the projector and become sticky and fail to hold.

A projectionist's guide spot and number should be placed as shown in Figure 9, page 117. The slide is placed in the slide carrier of the projector with the guide spot in the upper right corner facing away from the screen.

Transparencies can be made with the Polaroid Land Camera marketed by Polaroid Corp. Special films are used for $2\frac{1}{4}$ x $2\frac{1}{4}$ -inch and $3\frac{1}{4}$ x 4-inch slides. The scene or copy is snapped in the usual way. The transparency is developed for two minutes, dipped in a hardening solution then placed between plastic mounts which snap together and produce the finished slide. Pictures can be taken at a meeting and the slide shown a few minutes later.

Transparencies for overhead projection can be made from translucent or opaque originals in a reflex photocopier such as the Contura Constat. The Ozalid Projecto Printer* can also make direct copies on diazo single color foils. A variety of colors is available and combinations can be built up in a single transparency. Wilker-
son⁵² describes the process for making 2 x 2-inch slides from diazo single color films developed by the General Motors Engineering Staff.

Negative slides for graphs and diagrams are effective. They eliminate the glare from the large white areas

* Victorlite Industries, Inc., 4117 W. Jefferson Blvd., Los Angeles 16.

of positive slides and are easier to read. The lines and characters show white on a black background, or the curves can be colored by painting on the negative with watercolors or lacquer. The colors should be light. The order of preference is: yellow, orange, green, magenta, blue.²⁷ Ulman⁴⁸ points out that narrower lines should be used on copy for negative slides than are used for positive slides because a bright area appears wider than it actually is; it spills over into the adjacent dark area along the boundary ("Halation"). Negative slides eliminate the extra step of making a positive print and so are cheaper.

Negative slides absorb heat from the projector lamp more rapidly than positive slides, although this probably could be reduced by covering most of the black portion of negative slides with aluminum paint or foil.

The 2 x 2-inch slides are deservedly increasing in popularity because of their small bulk and weight, low cost, particularly for color photography, and the increasing availability of adequate projectors. These slides are prepared by putting pieces of film between cover glasses or in prepared mounts.

Hildebrand and O'Konski²⁵ overcome the bulk and weight handicap of 3½ x 4-inch glass slides by photographing their copy on 3½ x 4-inch film and sealing the film in transparent plastic envelopes. For projection, they place the film between specially prepared cover glasses. Matching semi-circular notches are ground into one of the long edges of two slide glasses. A film in its envelope is placed between the glasses, and binding tape is used to hinge the two glasses along the edge

opposite the notches. Two such pairs of glasses are prepared, one for holding the film being projected and the other for inserting the next film to be shown. The notches in the glasses permit easy insertion and removal of the envelope containing the film.

Emergency and temporary slides can be prepared by writing and drawing on glass or transparent film for mounting between glass covers. "Radio-mat"^{*} is a thin, transparent sheet mounted between carbon papers within a slide mask. The copy is typewritten and the transparent film can be mounted between cover glasses. "Slidecraft" † is a translucent self supporting acetate film having a satin finish on one side with or without a printed mask. On this one can draw, trace or write with colored pencils or inks. The sheet is then mounted between glasses for projection.²³

Fairhall¹⁹ reports that one can prepare slides by writing with ink on clear polystyrene film which has recently been swabbed with alcohol containing 2% acetone. Myer³⁷ recommends writing on ground glass, applying an oil or lacquer having the same index of refraction as the glass ‡ and mounting with a cover glass. The ground glass can be purchased, or prepared by grinding two glass slides together using a water suspension of 320-mesh carborundum. Various other methods of preparing slides without a camera are described by Goldblatt and Bates.²¹ Southern^{43a} describes the technique for

* Meadows A.V.C. Service, Mountain Lakes, N. J.

† Meadows A.V.C. Service, Mountain Lakes, N. J.

‡ "Permount" solution, Catalog Number So-P-15, Fisher Scientific Co., New York, N. Y., Washington, D. C., Pittsburgh, Pa., Chicago, Ill. and St. Louis, Mo.

photographing charts, diagrams or other copy drawn on a chalkboard, and mounting the negative in 2 x 2-inch prepared mounts or between 3½ x 4-inch slide glasses.

Models and Exhibits 8, 12, 18, 22, 29, 40, 42

For some purposes a scale model or exhibit can supplement words. It is the report. Examples are models of proposed layouts for machinery, buildings and process equipment. In addition to illustrating reports, models are used in education, advertising, sales promotion and as aids in design and construction of equipment and buildings. Scale models of refineries and chemical and other plants are used to train and orient operators, aid in the efficient location of equipment, supplement and clarify drawings and blueprints and give an over-all picture so that specialists and others can see the relation of their own parts to the whole. Maintenance people can study the layout and make recommendations which will reduce maintenance costs.

The scales for models of buildings range usually from one-eighth inch to the foot, to one inch to the foot. One-eighth inch and one-quarter inch scales are the commonest. The one-eighth inch scale has the advantage in that it approximates the scale of HO-Gage model railroads (3.5 mm. to the ft.). The O gage is one-fourth inch to the foot. The T gage one-tenth inch to the foot. Model rolling stock and railroad accessories are available in hobby shops.

The cost of building models, of course, varies widely, from a few dollars and some spare time work, up to one per cent of the total cost of the full scale project for

elaborate one inch to the foot models. The cost of one-fourth inch to the foot models have been estimated at two to eight cents per square foot of plant area represented. Another estimate for the same scale models is one-tenth per cent of full-scale plant cost.

Exhibits for reports, science fairs, trade exhibitions and museums are communications and should have the qualities required of all good communication: interest, unity, clarity, accuracy, brevity and, above all, appeal to the audience. Three-dimensional models are more effective than pictures and text. Reading matter should be confined to brief succinct labels and captions. The value of an exhibit is usually increased if an attendant is on hand to explain and to answer questions.

Materials used for making models are the same materials used for making anything else, wood, metal, cardboard, plastics, whatever you have on hand or can buy. Also useful are plaster of Paris, modeling and pottery clay. The list should include such things as old rubber boots, chewing gum and string. A high school girl made a working model of a static machine using tin foil pasted on old phonograph records.

Balsa wood can be shaped easily. Aluminum do-it-yourself sheets and extruded shapes are available at hardware stores. Structures and equipment made from clear plastic sheets and tubing give full visibility. Clear liquid castable plastics can be used to make such items as reaction vessels showing imbedded agitators, baffles, plates and coils. Piping can be represented by annealed iron baling wire which is easy to bend. Brass and copper wire are also used. Colored insulation will identify different lines.

Models of certain standard mechanical, chemical process, laboratory and office equipment can be bought.*

Some companies have set up model making shops in their design departments. Some make in quantity and keep in stock plastic standard parts for push-fit assembly. Also, commercial model making services are available.

Models of finished products for judging artistic design should be interpreted with caution. Industrial designers have found that the design of a product may appear more attractive as a small model than it does full size.†

Visual Aid Sources

Dealers and others are equipped to prepare various kinds of visual aids to order. Also available for rent and loan is a wealth of 2 x 2-inch slides, film strips and motion pictures covering many subjects such as agriculture, arts, business and industry, health and safety, medicine, religion, science and technology, sports and recreation. Some companies have movies for loan illustrating their products. Eastman Kodak pamphlets ‡ give bibliographies and indexes listing many sources of slides and films. Included are a list of periodicals which review films and filmstrips and a list of organizations in the audiovisual field.

* F. Ward Harman Associates, Halesite, L. I., N. Y.

Visual Plant Layouts, Inc., Oakmont, Allegheny County, Pa.

Visual Production Planning, Inc., Connellsville, Pa.

† W. E. L. Bunn, Fort Madison, Iowa. Private communication.

‡ "Some Sources of 2 x 2 inch Color Slides."

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9. PRESIDING AT MEETINGS

A presiding officer is a verbal traffic cop. His duty is to keep traffic moving and avoid jams and collisions.

No list of instructions or rules for conducting a meeting can substitute for tact and good judgment. Those traits must be cultivated. They can be improved by experience. However, even the inexperienced chairman can make thorough preparation and take advantage of the techniques which other peoples' experience has established. The techniques are derived from the basic fact that the function of a presiding officer is to facilitate the oral transfer of information.

CONFERENCES AND COMMITTEES ^{1, 4, 7, 11, 13}

A well planned and well conducted conference can produce results that are greater than the sum of all the initial ideas of the participants. Someone's remark will spark a new idea in your mind that he hadn't thought of and that you wouldn't have thought of without hearing his remark. Your new idea in turn may stimulate additional new ideas or modify old ones. All participants in the discussion must try to maintain the optimum temperature and pressure to promote that auto-catalytic reaction.

Although most of us participate in conferences more often than we lead them, what follows is given in terms

of suggestions for the leader or moderator. Reciting his problems makes it obvious what is the most effective conduct for the participants.

Plans

When you are called upon to organize a conference or discussion session, make careful plans for the meeting in advance. First define the purpose: what problem or problems are to be discussed; why; what result or conclusion is sought; what is expected of those invited to attend; whether all of those on the proposed list have an interest in the results of this conference and something to contribute; are there others who should be invited. Define the scope of subject matter to be discussed. Decide what is the limited area that can be covered at the proposed meeting. Prepare an outline of the main points. Your outline and your mind must be flexible so as to cope with unexpected turns the conference may take. After all, if you knew everything that would be said you wouldn't need to call a conference. If you send out a written notice of the meeting, you can include some of the background material that will enable you to shorten your introduction at the meeting. Except for the most casual and minor occasions, avoid an aimless "Let's get together and talk things over."

Arrangements and Conduct

If possible, have the group sit around a conference table. That arrangement is more conducive to relaxed discussion than seating the people in rows facing you. It avoids the schoolmaster-pupil atmosphere.

Conduct the meeting in a natural, easy and conversational manner. An informal atmosphere encourages responses. Tell the purpose of the meeting, what topics are to be discussed or what problem is to be attacked. It will take a few minutes for the members to become oriented so make your introduction thorough enough to give the necessary background. Several minutes should be sufficient for most occasions. Announce what the limitations in scope are to be, and any other ground rules. By your manner and conduct make it clear that you do not expect to give all the answers nor influence the opinions expressed. That doesn't mean that your manner should be lackadaisical and careless. On the contrary, you must be always alert to keep the meeting moving, under control and on the right track.

When you call for comments and discussion there will usually be some hesitation, as most people are reluctant to be the first to speak. Furthermore, the group has had only a few minutes to consider what has been brought up. In your introduction you listed some of the main topics to be discussed. When you ask for comments you might suggest one of those definite items as the starting point. Be patient and wait a little bit if no one responds. Give the people a chance to compose their thoughts. After a pause, rephrase the question. If you are well acquainted with the group, you might direct a question to one who has good judgment and has had experience or some dealings with the problem under consideration. Usually the comments will come freely after the first one.

Once the discussion has started, keep it going. Keep it on the beam. Keep everyone interested and participat-

ing and keep it impersonal. Ask questions that can't be answered by "Yes" or "No." Emphasize differences of opinion that arise. Ask for other comments on the point of difference. If an irrelevant comment is offered, suggest that discussion of that topic be deferred until the subject of the conference has been taken care of. Or pause and summarize briefly, emphasizing the question which has been under discussion and which hasn't been settled. Then ask what is the relation of the comment to the current discussion. Perhaps a connection can be given. If so, pursue it. If not, defer it. Quibbling over trifles is a form of irrelevance.

Keep organizing in your mind, the ideas which have been brought up during the discussion. Fit them into your outline, and modify the outline if necessary. Occasionally summarize the course of the discussion up to that point. List points of agreement that can serve as a foundation. Note points of disagreement that can be disregarded as insignificant or irrelevant. Also note points of disagreement that require further discussion. Mainly, your summaries should serve to keep the group oriented and directed to unsolved questions.

Problems

Occasionally one individual will talk too often or too long. He must be curbed tactfully so he won't monopolize the conversation and discourage the others. When he pauses for breath you might say "Let's take these points one at a time" and write the point on the blackboard or easel pad and ask the others to comment. Or, you can break in and say "That's a point worth discuss-

ing. What do the rest of you think about it?" If you noticed that someone seemed eager to speak during the long discourse, direct the question to him.

The person may be talking too long because he can't express his ideas clearly and briefly, or because he hasn't thought out his ideas thoroughly. If you know the gist of what he's trying to say, you can rephrase or summarize. If you don't know, ask specific questions around the point at issue, questions he can answer "Yes" or "No," that will clarify what he's trying to say.

Try to encourage and build up the shy individual who hasn't spoken and who may be inexperienced in group discussions. Point out the importance of the work he has done or his experience with some aspect of the discussion topic, and ask him if he would like to comment. But don't embarrass him by suddenly shooting complicated questions at him. Usually he will speak up with good ideas if you give him a little encouragement.

Sometimes a person will start a conversation with his neighbor. He may be merely seeking reassurance about a suggestion he plans to make to the group. However, prolonged private conversations must be discouraged. It is annoying to anyone who wants to listen to the proceedings to have his neighbor whispering. It is also distracting to the others. A pause, directing the group's attention to the conversation is usually sufficient to bring the offenders back to the meeting. You may have to say, good naturedly, "Will you speak a little louder so the rest of us can have the advantage of hearing what you're saying?" What they are saying probably is of interest to the group and should be brought out. If they are making

a date to play golf or talking over last night's bridge hand, they will take the rebuke as well deserved.

Sometimes the discussion will boil down to an argument based only on opinions which can't be verified by facts available at the time. Point out the futility of continuing such an argument and defer the question to a time when facts will be available.

Be Impartial

Sometimes it is best to avoid giving or even intimating judgments on comments offered. It's natural to say "That's right" or "That's the way it seems to me" or "I don't see how you figure that" when someone says something you agree with or disagree with. If you let your bias be known, some people will hesitate to express a contrary opinion.

Questions directed to you are usually meant as general questions for the group. In any case, it is usually best to refer the question to the group as a whole, especially if the question calls for an opinion. Sometimes you will see that the questioner would like to give an answer. Then, after recognizing the question as one for general discussion, ask the questioner what his own answer is. Avoid throwing all questions back to the asker or people will stop sticking their necks out. Some questions you should answer. One such question is a request for information you are in a position to furnish. Another is one specifically and pointedly directed to you, one so put that you can't gracefully pass it on. In that case, give your answer and for the sake of getting the talk back to the group, it may be appropriate to add, "Well, there's

one man's opinion. What does somebody else think about it? In some situations it is not necessary always to be neutral, although as presiding officer you should always be impartial in permitting expression of diverse opinions.

Closing

Bring the meeting to a close when the announced time limit is reached. Some of the people may have other engagements. Summarize with the group the conclusions reached or the course of action agreed upon. List any matters that are still undecided, and suggest another meeting if it seems justified. With the consent of the whole group the meeting can be continued and the unfinished matters settled. Also, regardless of the time, don't let the meeting drag on after the group has talked itself out. Again summarize and close.

TECHNICAL SESSIONS AT SCIENTIFIC MEETINGS⁸

Good programs of technical papers and discussion sessions don't *just happen*. They must be carefully prepared and controlled if they are to be of maximum benefit to the audience. And remember that the program is for the benefit of the audience, not for the glorification of the participants. Many of the thousands of people present have traveled hundreds of miles to attend the meeting. Also, their dues and registration fees make the meeting possible. They are the paying customers. They are entitled to hear a paper at the time the program

says it is to be given. Also they are entitled to hear an *understandable* presentation and to see slides they can read.

The chairman in charge of preparing for the meeting must take care of those things and many others. He should prepare a chronological check list, something like that shown below:

CHECK LIST

Preliminary organization of program

- Society Regulations
- Eligibility of speakers
- Registration
- Displays, demonstrations, preprints
- Send speakers a guide for slide preparation and oral delivery
- Review papers and slides
- Integrate subject matter in symposium papers
- Time schedule—inform speakers

Conducting the meeting

- Before meeting starts:
 - Meet the speakers
 - Plan distribution of samples or printed matter
 - Inspect meeting room. Check facilities:
 - Lantern, operator and screen
 - Blackboard, pointer, chalk, eraser
 - Lights, switches
 - P. A. System
 - Microwaves
 - Control
 - Reading desk
 - Water and glasses
 - Signal system to speakers
 - Special equipment, if required
 - Locate society Meetings Department and representative
 - Start the meeting *at the time scheduled*
 - During the meeting:
 - Watch the audience for signs that they cannot see or hear properly

Can the speaker be heard in back of room?

Signal the speaker "Closer to microphone," "Speak more slowly," etc., if necessary

Keep close check on time

Signal 1, 2 or 3-minute warning

Signal "close"

Discussion

Announce policy:

Subject and scope

Time limits

Questioners speak into microphone or chairman repeats questions

Techniques

Getting discussion started

Guiding and controlling discussion

Arrangements with Speakers

It is helpful to have a printed return form to send prospective speakers for your program. Provide spaces for answers to questions required by your society's regulations, such as society membership, speaker's profession, previous publication or presentation of the proposed paper. Also, provide spaces for listing the title, time for presentation, size of slides, and special facilities needed such as movie projector. List the society's regulations and list what facilities are routinely provided in the meeting room. If each prospective speaker fills in that form, signs and returns it, you will be relieved of the necessity for writing many follow-up letters.

On the opposite page is shown a form prepared for the American Chemical Society.²

Plan your symposia carefully and review the papers so that no speaker will need to say, "Most of the points I was going to cover have been mentioned by Dr. _____" and then spend the rest of his time giving a

**FORM TO BE SENT TO PROSPECTIVE SPEAKERS AT
AMERICAN CHEMICAL SOCIETY MEETINGS**

My status is:

Yes

No

American Chemist or Chemical Engineer

If not a chemist or chemical engineer,
what is your professional classification?

ACS Member?

Which co-author is ACS Member?

(ONE author must be a member of the ACS, if a resident of the U.S.,
unless all authors are non-chemists or non-chemical engineers).

Proposed Title:

Time required for presentation:

This paper has not been offered for publication elsewhere. This paper
will be the property of the A.C.S. to publish or to release for publica-
tion elsewhere at the discretion of the editors. Preprints, summaries
or bibliographies to be distributed at the meeting will be marked
"Not for publication or reproduction."

Other material to be distributed or displayed:

This paper was presented orally at:

Special equipment needed (in addition to standard projector, screen,
blackboard and pointer):

Signed

rambling discourse on trivialities. Also require the
speakers to submit the copy from which slides are to be
made, and see that they conform to the specifications
which insure legibility. Don't permit a speaker to use as
a slide a print of a typewritten page with six or eight
columns of figures. If you do, the speaker will glance at

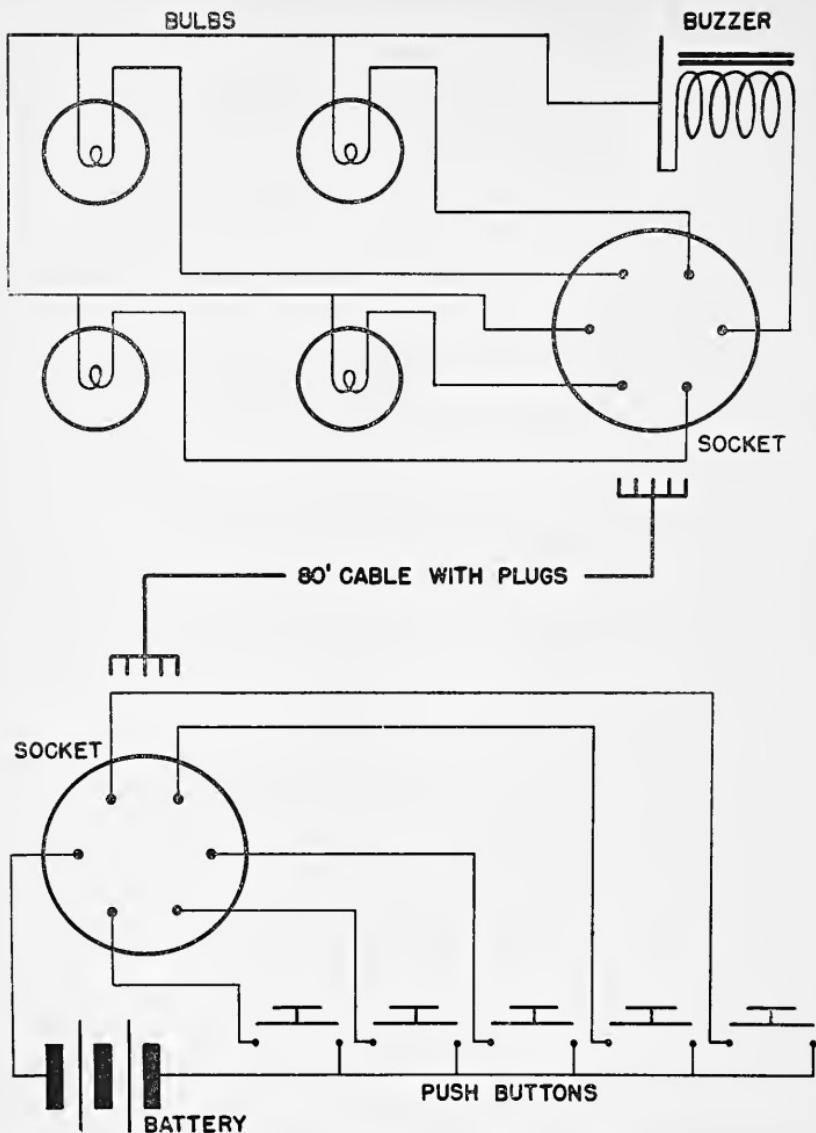


Figure 19. Wiring Diagram of Chairman-to-speaker Signaling System.
(Developed by T. E. R. Singer, New York, and Edward E. Thorpe, Montclair, N. J. for the Division of Chemical Literature of the American Chemical Society.)

the image on the screen and tell the audience cheerfully, "I hope you can read this."

You must have some arrangement for signalling the speakers "Stand closer to microphone," "Two minutes more," "Time is up," etc. It is distracting to walk to the platform and hand notes to the speaker. The best arrangement is a signal box with lights and buzzer. The system is wired so that you can press a button and light up the panel bearing the appropriate admonition visible only to the speaker. See Figure 19.

Find out how much time each speaker requires for his presentation or tell him how much time is allotted, and tell him that the time limit must be observed (unless this is taken care of on your printed form for speakers). Also arrange with the speakers to meet them before the meeting. You can meet them individually or collectively, informally or at a breakfast or luncheon. Thus, you will know that the speakers are on hand, and you can give them last-minute instructions about registration, time schedule, how you will signal them while they're speaking, how to distribute printed or other matter, and be sure that whatever facilities they require will be on hand.

Meeting Room and Facilities

When you inspect the meeting room actually check the facilities to see that they work. The lantern and reading light should be on circuits separate from room lights. Are the screen and blackboard visible from all parts of the room? Arrange to have the house lights dimmed when slides are being shown. Look up the attendant who

has been assigned to the room and be prepared to get word quickly to the Meetings Department if a lantern bulb burns out or if something is missing. Arrange for adjustment of the P.A. system if that should be necessary. See that the microphone is within the speaker's range when he is at the reading desk, at the blackboard, or pointing at the screen. Caution speakers about speaking only into the microphone. Lapel and neck microphones are preferable.

The Meeting

Start the meeting on time. Don't penalize the few who are on time for the benefit of those who come late.

Make your opening remarks and introductions brief and businesslike. Set a good example by maintaining a brisk pace.

Go to the back of the room and find out if the speaker can be heard, or arrange with someone to be there and signal to you.

If you have made adequate advance preparation, you can call time on a speaker when it is necessary, without embarrassment. You might announce to the audience that each speaker has agreed that the time allotted to him is adequate so the program will be kept on schedule. You can show the audience the signal box, and sound the buzzer which will be for the speaker who doesn't stop when he sees the silent "stop" signal.

If you haven't planned in advance and instructed your speakers about the schedule, you will be reluctant to walk to the platform and make the speaker stop when his time is up. You may tend to let him go on and on

hoping he'll stop in just a minute. Then each following speaker will expect to take his own full time and perhaps a little over, and your program will be so far off schedule that people will be disappointed when they come to hear a certain paper at a certain time.

But, no matter how you manage your program, do keep it on schedule. It is better to annoy *one* person by cutting him off than to annoy dozens or hundreds by letting him upset your program.

Neither should you let the program get ahead of schedule. If a paper or discussion closes sooner than expected, declare a recess until time for the next paper.

Plan the time so you can call a five-minute recess near the middle of a full half-day session to allow the audience to stand and stretch.

Discussion

Management of sessions at scientific meetings arranged to discuss a given topic without formal presentation of papers is governed by the principles discussed in a previous section of this chapter.

However, most discussion periods at scientific meetings consist principally of questions to the speaker following the presentation of the paper. Sometimes all papers are discussed at the end of the session. Some societies distribute preprints of the papers to all members. Then at the meeting the author gives only a brief summary which is followed by prepared discussion.

Most of the discussion following papers at scientific meetings can be handled by application of only a few of the principles previously mentioned: Keep the discus-

sion on the subject; questions and discussion should be limited to the intellectual content of the paper; questions and discussion from the floor should be spoken into a microphone. If no floor microphone is available, short questions may be repeated by the chairman into the platform microphone. Observe the time limit. Permit the author of the paper to make the final reply in case of critical comments.

Be Prepared

Most of the details essential to a successful meeting seem almost absurdly simple. Perhaps for that reason some of them are occasionally overlooked until too late. Check up on every detail. Don't take anything for granted. BE PREPARED.

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10. TALKING SCIENCE TO LAYMEN

Why

A bewildering array of scientific achievements is racing past us at an accelerating rate. Such advances in science and technology profoundly affect the life of every person, physically, economically and socially. Only a few generations ago almost everyone understood the operation of the devices then in common use, and with his own hands could make most of the devices he needed. Now we press buttons and push levers and mysterious and miraculous things happen. Instead of concocting remedies from herbs and roots, we have vitamin pills and "miracle drugs."

Most people are interested in these things, and want to know more about them and what they mean. People *need* to know something about the significance and consequences of scientific facts and theories in order to understand and cope with current problems.

Getting down to cases, what does talking science to laymen mean to you and me, and what should we do about it?

Our "standing" in our own community is simply what people think of us. What they think is based on how we look, act and talk. If we want people to think well of us, our work and our science, we must talk. And we must talk in such a manner that we are heard and understood.

As with individuals, no institution can decide whether or not it wants to bother with "Public Relations." It *has* public relations. Its only choice is *what kind*. Any institution, commercial or private, is merely a group of people working for a common purpose, and is judged partly by the way the individuals act and talk.

Support for education and research comes ultimately from the public through schools, public and private institutions and government. Taxpayers vote, as do trustees and directors of institutions. Politicians legislate and administer. All those people should be kept informed.

News disseminating agencies will fill newspaper columns, radio speakers and television screens with garbled and sensational "scientific news" unless they are adequately informed about scientific facts and their significance.

Curl and Rescher³ say, "In an age in which organized social pressure is the most potent political force, science cannot afford the risks of isolation or misunderstanding."

"The Public" is a composite of many overlapping segments. The attitudes toward science, the degree of understanding, and capacity for understanding vary among the segments. Among the attitudes are: vague wonder at "the miracles of science"; suspicion and fear of the unknown, verging on superstition; contempt for the "impractical" attitude and methods of scientists. The most generally held attitude, fortunately, is curiosity and genuine interest.

What

Talk about whatever interests you intensely. That topic you are likely to discuss in a way that is understandable. Your interest will give life to your delivery and appreciation to your audience.

The topic may be your job, and how it contributes to the over-all work or output of your institution, or to the benefit of the community. You may talk about some small aspect of your job that has interesting implications. The topic may be a problem you're working on or have worked on or would like to work on.

People are interested in new products, plastics, fabrics, drugs, and mechanical gadgets, things that affect their everyday lives directly. Many people are interested also in the broad aspects of the spirit and methods of science, and in stories of human achievements in science.

The topics to talk about are as broad and varied as the interests and imagination of the people working in science. However, stick to science, and to the part you know something about. Familiarity with some field of science or even eminence in that field doesn't, of itself, qualify one to sound off authoritatively on economic, social or political theory. In those fields we're just John Q. Public.

By all means, take part in civic affairs and espouse whatever cause you believe in, but remember that each field requires its own special talents. Avoid the attitude, "Now that the politicians have loused up the country, the scientists should step in and clean up the mess."

When, Where

One channel of communication to laymen is always open—everyday conversations. Everyone tells his friends and acquaintances about his work. Many of us have occasion to discuss technical matters with visitors to our institutions: callers, salesmen, customers, stockholders, trustees. We must explain technical matters to other departments of our company. Sales and Advertising need to know about properties and functions of products and processes. Production departments need to know about procedures, hazards and precautions.

Other, more formal, means include talks to luncheon clubs, schools and other local groups; appearances on radio and television; presentation of a story to science writers and reporters who write for the general public.

Most companies have a public relations department and most scientific societies have a news service for disseminating information about their respective institutions. It has been reported⁵ that there are 28,300 speaking engagements open each week. To help fill that demand for speakers, many companies and societies have speakers bureaus. Some companies have training courses for speakers, furnish organized information including "canned" talks, and display material and exhibits.

How

As scientists we are concerned with facts. The intrusion of feelings into the process of determining facts we consider profane and indecent. However, when we

talk science to laymen we are *interpreting* facts, and to give meaning to the facts we must relate them to the knowledge, experience and feelings of the listeners. We should tell less about the facts than about the *relevance* of the facts. Our necessary preoccupation with facts and our experience in discussing scientific work with our colleagues make it difficult for us to think of anything but the stark facts when we try to explain science to non-scientists.

The first thing to think of, then, is the background, experience and needs of the audience, whether it is one person or many. What is the purpose of the talk or conversation, to inform, to persuade, or to amuse? Which few of the many related facts are pertinent to this one question? How much does the listener already know about the subject?

Next comes consideration of what words to use. Instead of using a technical term, you will need to use two or three sentences or more to express the idea represented by the technical term. To express an abstraction, it is necessary to draw word pictures and analogies. You can usually give the listeners the "feel" of the idea without dragging out the explanation to hair-splitting accuracy. It is better if the listener has a slight understanding of a partial explanation than a complete misunderstanding of a thorough explanation. See Figure 20.

There are other things even more important than using simple, non-technical language and the composition of beguiling analogies and metaphors. You must give the audience a good reason for making the effort

to listen. You must catch their interest at the very start and make them *want* to listen.

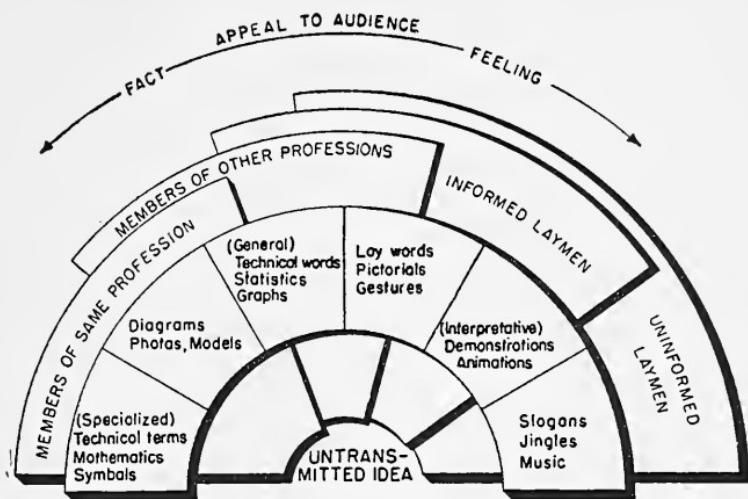


Figure 20. It Takes a Spectrum of Communication Media to Carry One Idea to All Men.

(Demmerle.⁴ Courtesy *Chemical Engineering*.)

When we prepare to give a talk, if we think of starting with an "Introduction," that puts our thoughts in a strait-jacket. We're apt to think of a logical and pedantic history, background and build-up. Instead, think of the "Beginning." Start with something that will attract attention, something interesting. It may be a personal experience, or an incident or accident that started or culminated a research project, or something that somebody did. Hill and Payne⁹ say, "'Incidents' are the 'hooks' the writer uses to grab the reader's coat tails to make him listen to his story."

After you have the attention and interest of the audience, make it easy for them to follow what you are dis-

cussing. Build the talk around a central idea and stick to that idea. Carefully organize the things you are going to talk about. Use transitional devices to lead the listener from step to step. Have an example to illustrate each main point. Describe action and people. Use pictures, diagrams and exhibits, or at least draw vivid mental pictures, even verbal cartoons.

Similarly, the ending (not "Conclusion") must be sharp and challenging and in keeping with the character and purpose of the talk.

When talking with laymen (or anyone else), don't be ponderous and dull. Keep your sense of humor. Sometimes levity and nonsense will make a point more vivid than reason and logic. Be patient with the profound misunderstandings of science you will find. It's our job to help clear up such misunderstandings.

When you accept an invitation to give a talk, be prepared. Of course you know the subject matter, you've organized the material and practiced the talk. But there are many other small but important details. Get all the information you can from the chairman about the audience and the occasion. Make definite arrangements with the chairman as to where you'll meet him and when. Be prepared to furnish a brief biographical sketch and summary of your talk for the press, if requested. Check the details in previous chapters.

Garrigus⁶ discusses the role of radio broadcasting in promoting a better public understanding of science. He describes the various program devices and techniques. Science speakers should seek the advice and direction of the radio station's program director and other professionals in radio broadcasting.

When giving your story to science writers and reporters and radio or television program directors, try to understand what they need. Don't be impatient with what we call "their tendency to sensationalize." They are trying to produce something that people will read, watch or listen to, and of course it will be "garbled" unless you tell them something more about your work than "Facts" and "Truth."

A science writer wouldn't start a story this way:

"In 1882 Umlaut and Gesundheit first succeeded in introducing a chlorine atom at the beta position in methyl-ethyl-dipropyl-stuff."

Instead, he might tell how young Gesundheit by chance first met the great Herr Doktor Umlaut while courting his neighbor's lovely daughter, Frieda. Then seventy-five years later another young man was working night and day to finish a research project so he too could get married. By chance, he stumbled upon the report of U. and G.'s research in the *Zeitschrift* and this proved to be the key to his problem.

"And so, chance and the love for a beautiful woman played a part in the development of this new toothpaste which glows in the dark."

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II. TECHNICAL LEGAL TESTIMONY

Giving technical testimony before a judge or jury is a highly specialized case of talking science to laymen. Most of the principles mentioned in Chapter 10 and some previous chapters are applicable here, but certain techniques must be modified or emphasized because of the formal legal requirements and procedures. Some additional techniques are necessary.

This chapter will review instructions for technical witnesses which have been suggested by experienced experts.¹⁻⁵ The legal aspects of expert testimony cannot be considered here. The witness will get such information from the lawyers who engage him. This chapter will consider technical testimony only as a special case of oral transfer of information.

Before the Trial

The preparation of your testimony may be simple recollections from your own experience with the facts in the case at issue, or may be the undertaking and completion of a thorough investigation. In any case, you must be thoroughly prepared. You must also be ready to answer questions on the periphery of the subject, questions that may be asked on cross-examination. Such questions may be asked to bring out further details and to test your knowledge of facts you brought

out previously. A witness is not permitted to say that a certain question does not have a bearing on the case.

The lawyers who seek your testimony will confer with you, usually in their offices. You will explain the facts. Tell them all the facts, especially any doubtful or damaging points. They may want to bring these points out in direct examination in the most favorable light before they are brought up by the opposite side. They will ask questions. They may tell which of the facts they want to emphasize. They may tell what relation those facts have to the legal aspects of the case.

They will also want to know about your career, education, experience, publications, whatever qualifies you to speak authoritatively on the subject of your testimony. Those are the first things the examining lawyer will ask when you are on the witness stand. He will probably ask a series of questions to bring out your qualifications rather than a general question such as "What are your qualifications?" He will establish your qualifications as an "expert" and as such you will be permitted later to give an *opinion*. Lay witnesses are permitted to testify only as to *facts*.

It is recommended that before the trial and during recesses you do not visit with opposing lawyers and witnesses, nor make statements about the trial or your testimony to strangers or to the press.

During the Trial

Your demeanor on the witness stand is of foremost importance. Display both modesty and assurance. Appearance, actions and manner should give the jury the

general impression of competence, sincerity, honesty and, above all, objectivity. You should show no personal interest in anything except establishing the facts. Keep your composure. Be relaxed. Don't squirm or fidget. Don't show apprehension or annoyance. Avoid arrogance. Avoid overdoing the common touch, don't try to be "just as common as an old shoe."

"Believed" must be added to the admonition in Chapter 6 that your words must be "heard, understood, and comprehended." *Every* juror must comprehend and believe the facts of your testimony because just one juror who doesn't can cause a "hung" jury.

After the preliminary questions your lawyer may ask you to "Tell the jury in your own words. . . ." Plan your description of facts and their interpretation just as you would for any other talk to laymen, as suggested in Chapter 10. Except, of course, that in giving testimony you must stick to relevant facts, and also the jury needs more than a vague idea of the significance of the facts. Have your ideas carefully organized and express them in simple language. Speak clearly and distinctly and specifically. Avoid vague abstract modifiers such as "considerable" and "enormously." Give examples and analogies in terms of the jurors' everyday experience.

Introduce pictures, diagrams and exhibits at intervals spaced to break monotony and to retain interest and attention, especially if your testimony is long. The preparation of exhibits, displays and other visual aids was discussed in Chapter 8. If they are well prepared, they will continue to testify after you have left the witness chair.

If your lawyer repeats a question with but little

change in wording, it probably means that your answer wasn't complete, that he wants to bring out something you said during the preliminary conferences. He can't tell you what to testify nor can he ask leading questions.

Don't say "I think . . ." You must "know . . .," or "conclude . . ." or the facts and exhibits "prove . . ."

Don't hedge every statement against all possible exceptions or quibble over trifles. If an abstract or obscure point is important in a technical description, explain the point, of course, and explain why it is important.

When testifying, a witness may refer to notes and records. However, such records may be inspected by opposing attorneys, and erasures, wisecracks and other extraneous matter on the page of notes may have to be explained.

Cross-examination

On cross-examination, the opposing lawyers may try to discredit your testimony. You must be alert for "trick" questions, confusing and complicated questions and subtle distortions of your previous testimony.

Answer questions truthfully and frankly but don't tell more truth than is necessary to answer the question. This is especially important when the cross-examiner is "fishing." If you don't know the answer to a question, say so frankly. No one is expected to know everything.

Hesitate an instant before answering each question on direct examination as well as on cross-examination. Give your answer deliberately and thoughtfully. On direct examination by the familiar lawyer, you know

what the questions are going to be and you have a ready answer. But on cross-examination by the opposing lawyer you don't know what the questions will be, and they won't be friendly, and they may not be easy to answer. So you will *need* to deliberate before answering, and the contrast with quick, glib answers under direct examination may leave an unfavorable impression. Hesitate even if you can answer instantly, your lawyer may want to object to the question.

Your qualifications may be challenged. You may be quizzed about your familiarity with publications and authorities in the field. If you never heard of a certain book or authority, don't hesitate to say so, maybe it doesn't exist. Avoid giving unqualified endorsement to any book, journal or authority. Some obscure passage or statement with which you do not agree may be quoted. Or a statement may be quoted out of context. You can say that So-and-So is a recognized authority in this field, you haven't read every word he ever wrote but his principal works are respected.

You may be asked a complicated multiple question and the answer to the last part may not be correct for the earlier parts. You can ask the clerk to repeat the question and answer each part in turn.

When confronted with a rapid series of short questions each obviously calling for "Yes," be alert for one that should be answered "No."

If your answer to a question is hurting his case, the opposing attorney may interrupt and ask another question. Or, he may keep firing questions faster than you can answer in order to make your answers appear incomplete and incoherent. If you are interrupted, you

may say, "I haven't finished answering the question," and the judge will permit you to finish.

If you are asked to give a categorical "Yes" or "No" to a question that requires a qualified answer, you may appeal to the judge and say that a true and full answer requires qualification. If he rules that you must answer "Yes" or "No," do so but add "With reservations."

If the answer to a question bolsters the other side, the cross-examiner may feign surprise, and shocked incredulity. He points an accusing finger at the witness, and in tones one would use when apprehending a child stealing candy, says "O-o-o-oh! So you've been talking with your attorneys. *Haven't* you?" For some strange reason, occasionally a witness will be infected with the feeling of guilt intended by the cross-examiner and will thoughtlessly blurt out "No." Well, there he is, caught in a lie. Of course his "No" was intended to be in answer to the *implication* that his attorneys had dictated what his testimony was to be. The answer to such a question should be "Of course! I told them the facts and answered a lot of their questions" with real surprise that anyone could be so stupid as to think a witness wouldn't talk with his attorneys. In spite of what anyone implies, talking with attorneys is not degrading.

The cross-examiner may repeat one of your answers with a clever distortion, "A minute ago you said '.....' now I'd like to ask '.....'" You may say "No, that is not correct. I'm sorry if I didn't make it clear." Then go ahead and explain it further. You may ask the clerk to read the question and the answer which was quoted, then correct the distortion. Be sure to make the mean-

ing clear because if he brought the question up, he thinks it's important.

A cross-examiner may suddenly pose a problem similar to the one at issue, and demand that you give the answer to it. You can say that such a question can't be answered without an investigation to determine the facts. A hypothetical question may be asked to test your reasoning and you will have to answer it. However, you can qualify your answer if necessary by saying there may be significant variables that were not included in the question.

Your lawyers may ask you to give an opinion as to the significance of the facts revealed in your investigation. Then the cross-examiner may ask, "But, after all, that's only an opinion, *isn't* it?" You can say something like, "Of course it's an opinion and I'm sure it's the only sound opinion that can be drawn from a thorough study of the facts."

Some of the references at the end of this chapter describe gambits a witness may employ in sparring with a cross-examiner. However, most scientists are not equipped intellectually or emotionally to engage in a "battle of wits" with a clever lawyer. Don't fight an enemy on his own ground and with weapons and conditions of his own choice. Stick to the facts. Make your answers truthful, relevant, lucid, dignified and convincing.

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12. SOCIAL CONVERSATION

This chapter will tell something about the occasions when we must *not* "Communicate Technical Information." Such occasions are dinner parties and other social gatherings where we meet with non-scientists.

Social contacts are a necessary part of our scientific careers. We meet with salesmen, dealers and representatives from other institutions at luncheons and dinners. After working hours, we entertain "Visiting Firemen" who come to our institutions. When we are on a business trip we are invited to our host's house to spend the evening and meet his wife and his neighbors. Of course, we all think we know how to get along on such occasions and most of us do, after a fashion, but sometimes we don't practice what we know. Too often we spend the evening discussing an interesting chemical problem with our chemist friend and leave our non-chemist companion with nothing to do but twiddle his thumbs. We have seen the lone engineer at a dinner party, sitting like a dolt, not saying a word, and even worse, making no effort to conceal his boredom with everything except the food.

Of course, we should do more than avoid such rudeness and bad manners. We should take some positive and active interest in the people who are present.

Few can aspire to the heights of conversational art reputed to Samuel Johnson and his Eighteenth Century

coffee house companions, or to the gentle wit and grace of a contemporary Clifton Fadiman, but we don't need to, fortunately. As a minimum we can do just a few simple things that will please other people and interest us at the same time. One time a young man told me how he got a reputation as a fine conversationalist, with wide-eyed wonder as though he had discovered one of life's ultimate verities, and indeed he had. He told that he had listened with attention and genuine interest to a hot-rod enthusiast tell about rebuilding and souping up old automobiles. My friend occasionally asked an intelligent question although it strained his meager knowledge of mechanics to do so. He pleased the enthusiast by permitting him to share his enthusiasm with someone else, and he himself learned something and had an interesting evening. When talking with people don't try to put on an act, you must be *really* interested, curious about things and places you never heard of, curious about what other people think and why. If you read, you will know at least a little something about the different kinds of things going on in the world, political and world affairs, sports, art, music, plays, books; you can comment and listen intelligently.

When we are thrust into a group of strangers we are likely to become dumb. We "Don't know what to talk about." Just remember that some of the others may feel as dumb as you. If you see someone standing alone, step up to him and say something, a comment on the gathering, on the hostess' arrangements, something about the guest of honor, anything. You probably were grateful when someone spoke to you one time when you were alone. Each person at a gathering should feel some re-

sponsibility for making an effort to contribute his share toward building an atmosphere of good humor and relaxation.

You don't need to be "Interested in People," but you do need to be interested in *ideas*. Some people almost break out in a rash when they come in contact with a new idea or a different point of view. So, as a defense mechanism against infection, their minds snap shut in the presence of an unfamiliar notion. You must learn to recognize the symptoms so you can fumigate future remarks and kill off the unusual. The principal clinical evidence of the affliction is an unseeing, glassy stare and eruption of cliches and other inanities.

When it's your turn to speak, talk about what interests you, something that is unusual, something that has some connection with something else. But don't tell *long* stories. Social conversation should be a light *exchange* of comments. If your story is interrupted and the talk drifts to another subject, forget the rest of your story and go along with the talk. Don't whisper behind your hand and mutter to your neighbor when he wants to listen to the whole group. Don't button-hole some hapless individual on the fringe of the group and talk business or try to sell him on your pet project.

What has been said so far in this chapter certainly is not a prescription for good conversation, but rather how to live with what we have. What has been recommended is the minimum requirement for merely *acceptable* social conduct. The situations cited were not invented, we have all seen them and others just as bad too many times. If we scientists and engineers are not to be considered narrow, uninteresting boors, we must

heed the admonitions and examples given. Then we can try to have *better* conversation, and it's worth the effort. It's fun.

Good conversation has an intoxicating quality, it is habit-forming. An addict is drawn irresistibly to other addicts. We converse to interest, amuse and stimulate, not to impress. We ourselves are interested, amused and stimulated by the original observations of the others and by the zest with which our remarks are batted back with an unexpected twist.

Good conversation is an art. In the July 1955 issue of *Holiday*, Clifton Fadiman discussed the radio program "Conversation" and listed the following observations on what encourages and what constitutes good conversation. It is not questions and answers, recounting personal experiences nor substituting anecdotes for opinion and jokes for wit. Good conversation comes from the trained mind, capable of observing and comparing and then generalizing on the level of general interest; judging experience rather than exchanging experiences; comparing ideas rather than personal tastes; drawing wit from contemplation of character rather than from recollection of the gossip column. The good conversationalist should not be handicapped by excessive information, rather, he must have depth, grace and agility of mind. The individual best informed on a given subject is not necessarily the best equipped to carry on a conversation about it.

Samuel Johnson said that conversation is different from talk, that it requires "knowledge . . . a command of words . . . imagination."

We can't retire to our own little world, bounded by test tubes and slide rules. We are part of the great, wide universe and we have to deal with it whether we like it or not. Our only choice is how *well* we deal with it. We should like it. It's full of interesting things. Let's cultivate the retorts that aren't found in laboratories.

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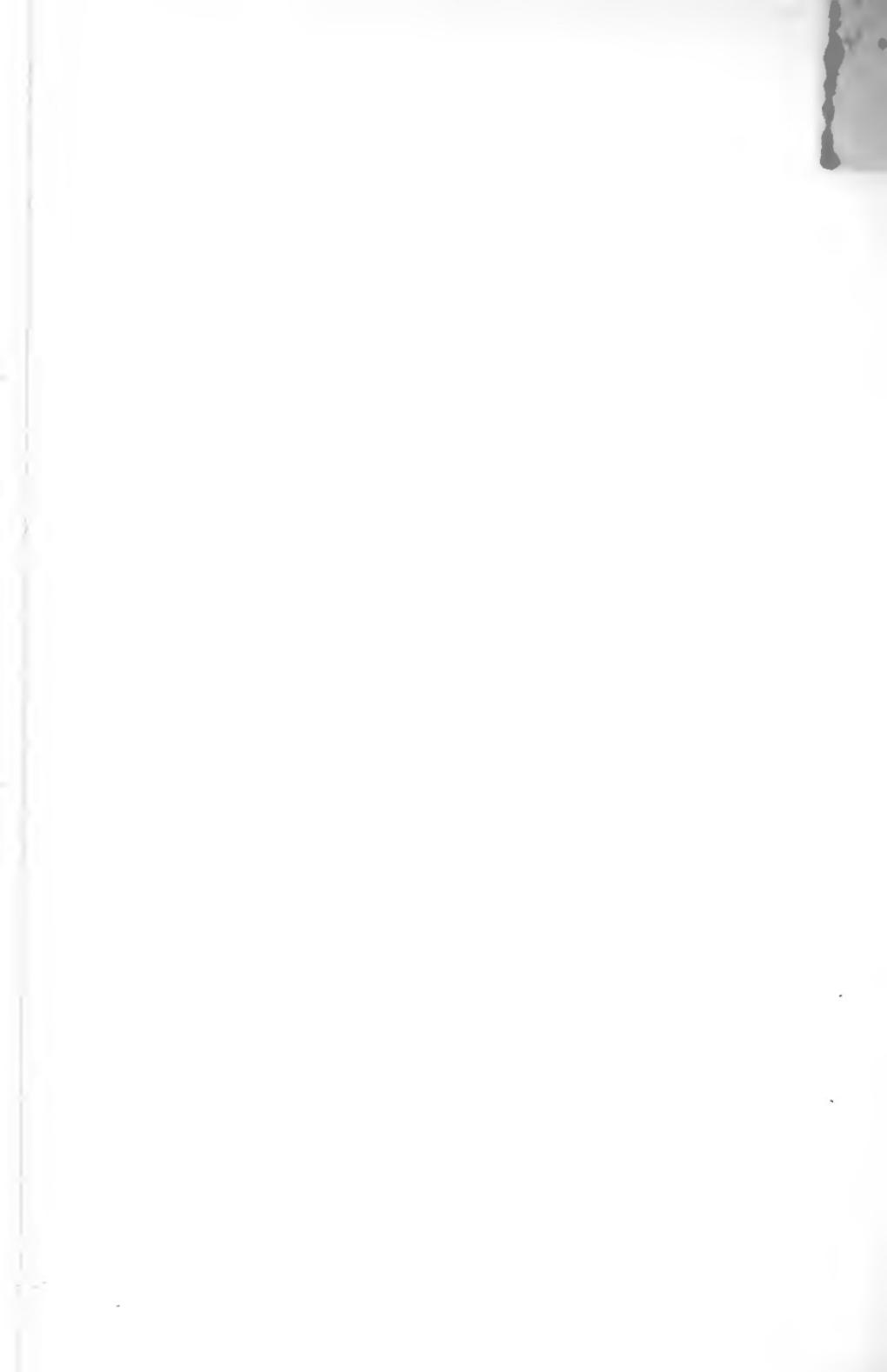
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